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ABSTRACT

A project examined the mathematics and science performance of vocational students in Ohio. Part I of the study achieved the first objective--to report the science and mathematics content contained within the Ohio Vocational Achievement Tests for the 38 program areas. Each of the 38 tests was presented and found to have sound psychometric properties. In general, each test contained reasonable numbers of science and mathematics items. Part II achieved the second and third objectives--to determine the level of functioning and the proportion of correctly answered questions by juniors and seniors enrolled in vocational education programs in the areas of science and mathematics in each program area. In general, seniors outperformed juniors in each program area; the level of performance was at a reasonable level. Performance across the 38 levels on both science and mathematics varied among the different vocational groups. Part III achieved the fourth objective--a pilot study to determine the feasibility of experimentally comparing students enrolled in vocational education programs with students enrolled in traditional education programs on common paper and pencil indicators of science and mathematics performance. Performance of students in three vocational education programs compared favorably with students in college preparatory and general academic programs. (YLB)

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Comparison Study of Vocational and Traditional Students on Mathematics and Science Achievement

TECHNICAL REPORT

April 1986

Dr. William E. Loadman
Director

Submitted to the Ohio Department of Education Division of Vocational and Career Education in partial fulfillment of research grant.

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CE044207

Technical Report

Comparison of Students Enrolled in Vocational Education with Students Enrolled in Traditional Education on Common Indicators of Science and Mathematics Knowledge

April 1986

Prepared by

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This has been a fun study to conduct and I am pleased to present it and to have been a part of it.

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INTRODUCTION

Vocational education has, during the last several decades made a substantial impact on persons in the workforce throughout the United States. This has been achieved through the education and training of a large segment of our force through mechanisms outside of the traditional academic classroom. The increasing demand for more sophisticated and specialized education, for students to keep pace with advancing technology, is reflected in the curricular offerings and modifications to curriculum in existing schools of vocational education. Recent increases in science and mathematics requirements of students in Ohio to obtain a high school diploma are reflective of concerns about the educational system and present difficult problems for vocational educators.

There has been large scale general criticism of the educational system in the United States, and particular criticism of students' lack of mathematics and science knowledge. Students in the state of Ohio will be required to demonstrate adequate knowledge of mathematics and science in order to obtain their high school diploma.

Students in vocational education programs are obtaining substantial amounts of science and mathematics within their program curricula. Questions have been consistently raised, however, about the quality, depth, and contents of these curricula offerings.

Hard data that could be used to obtain an indication of the quality, depth, and content of science and mathematics offerings within vocational education programs across the state of Ohio is needed to address these questions and problems.

This study was initiated to address those concerns through the systematic collection and analysis of relevant information. The following five objectives were used to guide this study:

1. Examine and report the science and mathematics content contained within the Ohio Vocational Education Exams (by program area).

2. Determine the proportion of juniors and seniors enrolled in vocational education programs who correctly answer the items which reflect science and mathematics content (by program area).

3. Determine the level of functioning of students enrolled in vocational education programs in the areas of science and mathematics (by program area).

4. Initiate a pilot study to determine the feasibility of experimentally comparing students enrolled in vocational education programs with students in traditional education programs on common indicators of science and mathematics knowledge (by program area).

5. Communicate the findings in writing to appropriate professional audiences.

The purpose of this technical report is to examine the mathematics and science performance of vocational students in the State of Ohio. The data base, provided by the Vocational Instruction Materials Laboratory, The Ohio State University (OSU), was analyzed to obtain an indication of performance in mathematics and science of students attending vocational programs. A pilot study was conducted under this project to determine the feasibility of experimentally comparing the indicators of mathematics and science knowledge of students enrolled in vocational education and the students enrolled in traditional education.

Hard data for this project was obtained from administering the Ohio Vocational Achievement Tests to students in 38 programs in Agriculture, Business and Office, Marketing, Health Occupation, Home Economics, and Trade and Industrial Education in 1985. The testing coordinated by the Vocational Instruction Materials Laboratory. These data were analyzed to obtain the indicators of mathematics and science ability of vocational students by program area. The indicators found to be most appropriate for this study include;-

(i) Mean Percentages of correctly answered mathematics and science questions by juniors and seniors on the 38 achievement tests;

(ii) Mean raw scores and standard deviations on the level of functioning of the students enrolled in vocational education programs in the areas of mathematics and science.

In conducting the pilot study, three forms of the Ohio Vocational Achievement Tests: Welding, Home Economics Food Services and Carpentry were modified. These modified test forms were administered to seniors in college-bound and general education programs. The mean percentages of correctly answered mathematics and science questions by students, as well as the mean raw scores and standard deviations were computed. The comparison was made between the common indicators, obtained from the students enrolled in vocational, college-bound and general education, to determine the feasibility of the experimental comparative study.

In this report, the results of the study are presented in three parts. In the first part of the report (response to objective 1), the descriptions of the Ohio Vocational Achievement Tests in 38 programs are presented. The second part (response to objectives 2 and 3) presents the performance of vocational students as indicated by;-

(1) the mean percentages of correctly answered mathematics and science questions included in those 38 tests, and

(2) the raw means and standard deviations on mathematics and science items.

Part three of this report (response to objective 4) provides information on the pilot study which compares the students enrolled in vocational versus traditional education by using these common indicators. Finally, this written report is in part the response to objective 5.

Part I Test Description

Part I Test Description: Ohio Vocational Achievement Tests

An indication of quality, depth and content of science and mathematics is obtained by analyzing the test scores of students in 38 programs who took the Ohio Vocational Education Achievement Tests in 1985. The Tests were developed to provide the information for the improvement of the instruction. The purpose of the Achievement Test Program is outlined by the following eight goals (Walter & Parks, 1984):

Objectives of Tests

To: (1) help determine if the instructional objectives have been achieved.

(2) provide a reliable criterion for reviewing the curriculum and improving instruction.

(3) motivate students and teachers.

(4) identify deficiencies in facilities and equipment.

(5) assist in the process of supervision.

(6) help identify strengths and weaknesses of the instruction.

(7) help identify strengths and weaknesses of student learning.

(8) help evaluate reference materials.

Test Development

In developing the tests, the tasks performed by those working in each area were analyzed. Science principles, mathematical skills and communication skills necessary for successful performance were listed for each activity. The task/activity analysis resulted in information from which all items in the Vocational Education Achievement Tests were developed. Strengths and weaknesses indicated in subtest scores suggest a review of Lesson Plan and Course of Study to take advantage of program strengths and to improve the weak areas.

The tests were administered and then reviewed based on the students' responses. The weak items were replaced, rewritten or eliminated. The validation of the test was performed, and the items not contributing favorably to the test were revised or eliminated. The revised tests could be administered to measure skills and understanding in specific vocational areas. These tests, including the task/activity analysis, are reviewed each year to ensure applicability to current occupational practices and requirements.

Each achievement test in 38 vocational areas consisted of 269-384 multiple-choice questions with four-alternative responses. The test was divided into two parts: Part I and Part II. In both parts, the test is comprised of 7-16 subtests according to the duties identified as the requirements for a specific occupation in the task analysis.

Mathematics and Science Content

Test items which measure the ability of students in mathematics and science are included in the context of these subtests. The tests were analyzed to determine whether the items were mathematics or science questions. The items were also classified into specific branches of the disciplines of mathematics and science.

The subject areas identified for mathematics were

- Basic mathematics
- Algebra
- Plane geometry
- Trigonometry

The subject areas identified for science were

- Physics
- Chemistry
- Botony
- Zoology
- Geology/Meteorology
- Microbiology
- Anatomy
- Physiology
- Psychology

The number and proportion of mathematics and science questions included in the tests are presented in Table 1.

In Table 1, the total number of test items range from 269-384. The total numbers of mathematics and science questions range from 4-121 and 2-264 respectively. The proportions of mathematics and science questions to the total number of test items are .01-.40 and .01-.70 respectively. Some items were identifed both as mathematics and science questions. For this reason, the total number of questions in mathematics and science might exceed the total number of questions in the test, e.g., see industrial electronics. Pages 10 through 47 contain a description of each of the 38 vocational area tests. Included in this description is a listing of the subtests, the proportion of items in the science and math areas included on the test, and a sample science and math item.

Academic Aptitude

Another aspect of the Ohio Vocational Testing Program is an indicator of academic aptitude. This measure is titled the Short Form Test of Academic Aptitude (SFTAA) level 5. This test has demonstrated high levels of validity and reliability and is well recognized as a good indicator of general academic ability. The test is comprised of 85 items broken down into four subtests: (a) sequence (20 items), (b) analogies (20 items), (c) vocabulary (25 items), and (d) memory (20 items). The test yields separate scores for each subtest as well as a non-language subtest score (sequence plus analogies), a language subtest score (vocabulary plus memory) and a total academic aptitude score (sum of the four subtests).

Table 1

Number and Percentage of Mathematics and Science Content Items in each Vocational Area

VOCATIONAL AREA	MATH		SCI		TOTAL	
	total	%	total	%	Math & Sci	TOTAL
AGRICULTURAL EDUCATION						
Agricultural Business	41	13	40	13	81	308
Agricultural Mechanics	20	6	74	22	94	342
Farm Management	80	26	37	12	117	304
Horticulture	14	4	92	26	106	349
Production Agriculture	20	6	85	24	105	349
BUSINESS AND OFFICE EDUCATION						
Accounting/Computing	47	15	5	2	52	321
Clerk Typist	23	7	4	1	27	333
Clerk Stenographer	24	9	10	6	34	278
Data Processing	33	10	264	76	294	346
General Office Clerk	26	9	7	2	33	285
Word Processing	15	4	42	12	57	341
MARKETING EDUCATION						
Apparel and Accessories	22	6	2	1	24	342
D.E. Food Service Personnel	18	6	31	10	49	315
Food Marketing	38	10	15	4	53	384
General Merchandising	37	10	13	4	50	353
HEALTH OCCUPATIONS EDUCATION						
Dental Assisting	5	1	192	56	197	344
Medical Assisting	22	6	227	64	274	356
Diversified Health Occupations	15	4	241	63	256	383
HOME ECONOMICS EDUCATION						
Fabric Services	22	6	27	7	49	371
Home Economics Food Services	20	5	63	17	83	376
Community and Home Services	4	1	109	31	113	354
Child Care Services	5	2	151	56	156	269

Table 1 (continued)

	MATH		SCI		TOTAL	
	total	%	total	%	Math & Sci	TOTAL
TRADE AND INDUSTRIAL EDUCATION						
Auto Body Mechanics	25	7	77	23	102	334
Automotive Mechanics	38	12	109	34	147	325
Small Engine Repair	40	12	79	23	119	338
Diesel Mechanics	16	5	60	18	76	332
Carpentry	81	25	40	12	121	325
Construction Electricity	55	16	98	29	153	342
Heating, Air Conditioning and Refrig.	6	2	75	25	81	302
Masonry	23	8	19	6	47	299
Communication Products Electronics	76	22	257	76	333	338
Industrical Electronics	84	26	257	79	341	326
Commercial Art	41	13	43	14	84	311
Drafting	121	40	62	20	183	303
Lithographic Printing	43	12	54	15	97	364
Machine Trades	57	15	24	6	81	384
Welding	40	12	68	20	108	333
Cosmetology	9	3	227	65	230	338

Sample Tests

Test 1. Agricultural Business.

There are 9 subtests in 2 parts of the test according to the previously identified test analysis.

Part 1 contains the following subtests

1. Agricultural Careers
2. Human Relations
3. Office Procedures
4. Agricultural Service Animals
5. Advertising and Promotions

Part 2 contains the following subtests

6. Agricultural Service-Plants
7. Sales
8. Marketing and Storage
9. Money Management

The mathematics questions are in basic mathematics and represent 13% of the total test items. The proportion of science questions is 13%. The subject matter areas in which science questions are found include predominantly chemistry and botany. Few questions are found in the area of zoology, microbiology, anatomy and psychology.

Sample item.

Mathematics

The due date of a 90-day note dated dated March 17 is:

1. May 15.
2. May 17.
3. June 14.
4. June 15.

Science

Molasses is used as a feed ingredient in a ration mainly to supply:

1. protein.
2. vitamins.
3. carbohydrates.
4. palatability.

Test 2. Agricultural Mechanics.

This test contains 14 subtests in two parts as follows:

Part 1	Part 2
1. Service Repair Engine	8. Charging Systems & Accessories
2. Carburation Systems	9. Cranking Systems
3. Diesel Engines	10. Ignition Systems
4. Cooling Systems	11. Power Trains and Transmissions
5. Hydraulic Systems	12. Metal Fabrication & Refinishing
6. Brake & Steering	13. Heating, Ventilation & Air Conditioning
7. Equipment Assembly	14. Personal Development

There are 6% mathematics questions and 22% science questions in this test. The predominant subject matter area for mathematics questions is basic mathematics. The science questions are concentrated in physics and chemistry.

Sample items.

Mathematics

The manufacturer specifications state that a reservoir holds 46 qt. of oil, how many gallons are required to fill the system?

1. 4.6 gallons.
2. 5 3/4 gallons.
3. 11½ gallons.
4. 23 gallons

Science

If you replace a cylinder in a hydraulic system with one of a larger diameter, it will lift:

1. more and move faster.
2. more and move slower.
3. less and move faster.
4. less and move slower.

Test 3. Farm Management.

This test contains 11 subtests

Part 1		Part 2	
1.	Plan & Supervise work	6.	Plan Crop Enterprise
2.	Analyze Farm Records	7.	Market Farm Products
3.	Building & Structures	8.	Plan Livestock Enterprise
4.	Finance Farm Operations	9.	Equipment & Machinery
5.	Maintain Inventory of Supplies	10.	General Management Duties
		11.	Employment Procedures

There are 26% mathematics questions and 12% science questions included in the test. There is a stronger emphasis on mathematics especially on basic mathematics than science. The emphasized content areas on science are physics, chemistry, and physiology. There are some questions in geometry, microbiology, psychology and geology.

Sample items.

Mathematics

If a farmer moves feed storage to an area closer to the feeder, 40 minutes of time will be saved daily. The lot is used 275 days each year, and labor cost is $3.50 an hour. How much savings in labor would result in one year if the feed storage was moved?

1. $ 425.95
2. $ 641.66
3. $ 841.05
4. $ 38,500.00

Science

There are different purposes for ventilating livestock buildings in warm weather vs. cold weather. What primary function does ventilation serve in cold weather?

1. Admits light into the building.
2. Moves odor out of the building.
3. Vents moisture laden air to the outside of the building.
4. Moves air and moderates temperature of the building

Test 4. Horticulture.

This test contains 10 subtests

Part 1	Part 2
1. Soil and Plant Science	7. Turf Services
2. Production Floriculture	8. Nursery
3. Retail Floriculture	9. Landscaping
4. Garden Center	10. Equipment and Mechanics
5. Personal Development	
6. Fruit and Vegetable Production	

Science is emphasized more than mathematics in this test. The proportion of science questions to the total number of test items is 26% while the mathematics questions comprise 4%. Chemistry, botany, physics are three areas of content which are emphasized most for science while general math is emphasized most in the mathematics area.

Sample items.

Mathematics

The total square footage of a bed 9' by 36' is:

1. 224 square feet.
2. 274 square feet.
3. 324 square feet.
4. 374 square feet.

Science

When planting annual plants in heavy soils, the root should be:

1. ¼ exposed.
2. ½ exposed.
3. 3/4 exposed.
4. completely covered.

Test 5. Production Agriculture.

Twelve subtests are included in this test. They are:

Part 1	Part 2
1. Beef Production	7. Operator Equipment Maintanance
2. Small Grain Production	8. Dairy Production
3. Sheep Production	9. Corn Production
4. Soybean Production	10. Swine Production
5. Crop Chemical Application	11. Forage Production
6. Agricultural Construction	12. Employment Procedures

There are 6% mathematics questions and 24% science questions in this test. All mathematics questions are in basic mathematics. Physiology, physics, chemistry and botany are subject matter areas where most of the questions in science are found.

Sample items.

Mathematics

A machine's harvesting capacity is 300 bushels of corn per hour when the average corn yield is 150 bushels per acre. If a farmer works 100 hours, how many acres of corn can be harvested?

1. 50 acres.
2. 150 acres.
3. 200 acres.
4. 450 acres.

Science

A common respiratory disease when young beef are sold and trucked to new locations is:

1. trucking fever.
2. respiratory fever.
3. shipping fever.
4. young fever.

Business and Office Education

Test 6. Accounting/Computing Clerk.

There are 10 subtests included in this test. They are:

Part 1	Part 2
1. Sales & Receivables	6. Processing Purchases & Payables
2. Payroll Records	7. Specialized Accounting & Office Functions
3. Maintaining Inventory Records & Files	8. Cash Receipt and Payments
4. Completing the Accounting Cycle	9. Mechanical & Electronic Data Accounting
5. Worksheet Information	10. Employment Procedures

The proportions of mathematics and science questions included in this test to the total number of test items are 15 and 2 percent respectively. The subject matter area where all mathematics and science questions are found are basic mathematics and physics.

Sample items.

Mathematics

Alice Lincoln's capital at the beginning of the accounting period was $6,000. She withdrew $400. Her capital at the end of the accounting period was $6,300. Net income was:

1. $ 300.
2. $ 500.
3. $ 600.
4. $ 700.

Science

An input/output device that can transmit and receive data over the telephone is known as:

1. a terminal.
2. an optical scanner.
3. an external storage device.
4. a printer.

Test 7. Clerk Stenographer.

This test includes 7 subtests. They are:

Part 1	Part 2
1. Dictation	4. Communications
2. Correspondence	5. Copy Reproductions
3. Financial Records	6. Record Management
	7. Personal Development/ Employment

Mathematical and science questions included in this test are 9 and 6 percent of the total number of test questions respectively. All mathematics questions are predominantly found in the area of basic mathematics. The science questions are found in the area of physics and geology.

Sample items.

Mathematics

If 50 is used as the center point of the paper, you would set the two margin stops for a 70-space line at:

1. 12 and 90.
2. 15 and 85.
3. 20 and 85.
4. 25 and 80.

Science

A detailed set of instructions fed into the computer to enable the processing of data is called:

1. statistical computations.
2. processed data.
3. flow charts.
4. a computer program.

Test 8. Clerk Typist.

There are 10 subtests included in this test. They are:

Part 1	Part 2
1. Letters, Memos & Envelopes	6. Reports, Manuscripts & Forms
2. Filing	7. Accounting/Calculating
3. Proofreading & Editing	8. Telephone & Receptionist Duties
4. Mail Procedures	9. Machine Transcription/Word Processing
5. Employment Procedures/ Human Relations	10. Reprographics

Mathematical questions and science questions included in this test are 8 and 1 percent of total number of test items respectively. All questions are on basic mathematics and physics.

Sample items.

Mathematics

Monthly sales are as follow: January, $ 9,800; February, $ 10,100; March, $ 7,500; and April, $ 9,000. The average monthly sales is:

1. $ 8,100.
2. $ 9,100.
3. $ 12,133.
4. $ 36,400.

Science

A visual display word processing machine uses a:

1. computerized filing system.
2. magnetic bell-type recording device.
3. TV-like screen (CRT).
4. facsimile type machine.

Test 9. Data Processing.

There are 10 subtests included in this test. They are:

Part 1	Part 2
1. Computer Systems	6. Flow Charting
2. Clerical Procedures	7. Data Entry
3. Programming Languages	8. Operations
4. Human Relations	9. Business Math/Accounting
5. Automated Electronic D.P. Equipment	10. Employment Procedures

The number of mathematics and science questions in this test are 10 and 76% of the total number of test questions respectively. The mathematics questions are concentrated in basic mathematics. Some questions are found in the content area of algebra. Physics is the subject matter area where all the science questions are found.

Sample items.

Mathematics

The number 357 converted to binary coded decimal (BCD) is:

1. 0011 0011 0101.
2. 0011 0101 0111.
3. 0101 0101 0011.
4. 0111 0111 0101.

Science

When the file protection ring is affixed to a magnetic tape reel, the computer operater finds it is impossible to:

1. remove the tape reel from tape unit.
2. check the tape out of the library.
3. write information on the tape.
4. read information from the tape.

Test 10. General Office Clerk.

Eleven subtests are included in this test. They are:

Part 1	Part 2
1. Typing Forms and Reports	6. Receptionist Duties
2. Reprographics	7. Letters and Correspondence
3. Employment Seeking	8. Financial Records
4. Composition and Editing	9. Telephone Communications
5. Records Management	10. Word Processing
	11. Accounting Functions

There are 9% mathematics questions and 2% science questions in this test. All mathematics questions are found in the content area of basic mathematics. The predominant subject matter area where science questions are concentrated is physics.

Sample items.

Mathematics

Compute the ordinary simple interest on $ 300 at 8% for 120 days. Use a 360-day year.

1. $ 6.
2. $ 8.
3. $ 12.
4. $ 24.

Science

Recording data on cards or tapes so the data can be processed by the computer is called:

1. input.
2. output.
3. storage.
4. origin.

Test 11. Word Processing.

There are ten subtests included in this test. They are:

Part 1	Part 2
1. Typing & Transcription	6. Automated Word Processing Equipment
2. Reprographics	7. Receptionist Duties
3. Word Processing Concept & Procedures	8. Composition & Dictation
4. Business Transaction	9. Records Management
5. Proofreading and Editing	10. Employment Procedures

There are 4% mathematics questions and 12% science included in this test. The mathematics questions are all in basic mathematics. The science questions are concentrated in physics; some questions are in psychology.

Sample items.

Mathematics

If 30 is used as the center point of the paper, you would center ANNUAL DINNER DANCE by beginning to type at:

1. 12.
2. 15.
3. 20.
4. 21.

Science

A device which can read printed or typed characters and convert them into input for a visual text editor is:

1. OCR.
2. OCC.
3. CPU.
4. CRT.

Marketing Education (Distributive Education)

Test 12. Apparel and Accessories.

There are 10 subtests included in this test. They are:

Part 1	Part 2
1. Cashiering	6. Product Knowledge
2. Merchandise Display	7. Receiving & Marking Merchandise
3. Sales	8. Support Functions
4. Stockkeeping & Inventory Control	9. Customer Services
5. First Line Management	10. Obtain Employment

There are 6 and 1 percent mathematics and science questions respectively in this test. The questions are concentrated in basic mathematics and chemistry.

Sample items.

Mathematics

The store is running a 20% reduction sale. How much does a customer pay for a coat priced at $ 59.95?

1. $ 11.99.
2. $ 38.37.
3. $ 47.96.
4. $ 50.36.

Science

Polyester yarns are primarily used in fabrics to:

1. increase durability.
2. repel moths and insects.
3. provide wash and wear benefits.
4. simplify construction of a garment.

Test 13. D.E. Food Service Personnel.

The test contains 12 subtests as follows:

Part 1	Part 2
1. Restaurant Management	6. Employment Procedures
2. Inventory & Purchasing Procedures	7. Human Relations
3. Business Principles	8. Communications
4. Waiter/Waitressing	9. Selling Principles
5. Cashiering	10. Advertising
	11. Product/Service Information
	12. Safety & Housekeeping

The number of mathematics and science questions are 6 and 10 percent of the total number of test questions respectively. The predominant subject matter areas for mathematics questions is basic mathematics, and for science questions in psychology.

Sample items.

Mathematics

What is the sales tax on the following items, if the tax rate is 4%?

2 Cheeseburger Platters - $2.95 ea.
1 Ham Dinner - $2.65 ea.

1. $ .21.
2. $ .31.
3. $ .38.
4. $ .42.

Science

Motives that prompt action because of the appeal of love, fear, vanity, pride, prestige, desire for comfort, and desire to be envied are:

1. rational buying motives.
2. selective buying motives.
3. patronage buying motives.
4. emotional buying motives.

Test 14. Food Marketing.

There are 11 subtests included in this test. They are:

Part 1	Part 2
1. Employment Procedures	6. Public Relations
2. Human Relations	7. Service Technology
3. Business Principles	8. Product Information
4. Communications	9. Pricing
5. Financial Operations	10. Operations
	11. Advertising and Display

The number of mathematics questions are 10 percent and the number of science questions are 4 percent of the total questions in the test. The subject matter area where mathematics questions are concentrated is in basic mathematics. And the predominant area where science questions are found is psychology.

Sample items.

Mathematics

A customer's purchase totals $ 7.98, but they only have $ 7.00. The customer decides not to buy an item worth $ 2.39. What is the new purchase price?

1. $ 4.61.
2. $ 5.59.
3. $ 5.79.
4. $ 5.91.

Science

The best method of handling a difficult customer would be to:

1. maintain a superior attitude.
2. refer the customer to a sales representative.
3. offer the customer a sample of another product.
4. ask questions to determine why the customer is upset.

Test 15. General Merchandising.

There are 12 subtests included in this test. They are:

Part 1	Part 2
1. Employment Procedures	6. Selling
2. Human Relation	7. Marketing
3. Business Principles	8. Cashiering
4. Communications	9. Inventory Procedures
5. Financial Transactions	10. Housekeeping & Security
	11. Advertising & Display
	12. Product & Service Technology

The number of mathematics and science questions are 10 and 4 percent of the total questions in the test respectively. All mathematics questions are found in the area of basic mathematics whereas the science questions are concentrated in psychology.

Sample items.

Mathematics

Clyde's Cycle Shop offered to sell a $ 275.00 motorcycle for 10% down and $ 18.20 a month for 18 months. What is the finance charge?

1. $ 52.60.
2. $ 80.10.
3. $ 247.50.
4. $ 327.60.

Science

The best definition of a buying motive is:

1. a force which directs behavior toward goals.
2. a determinant of consumer behavior.
3. the reason why people purchase items.
4. an internal structure where experience and behavior are related.

Health Occupations Education

Test 16. Dental Assisting.

This test includes 14 subtests which are:

Part 1		Part 2	
1.	Anatomy	8.	Radiology
2.	Microbiology & Sterilization	9.	Dental Office Management
3.	Dental Emergencies & Pharmacology	10.	Chairside Assisting - Basic
4.	Dental Laboratory	11.	Chairside Assisting - Prosthetics
5.	Restorative & Impression Materials	12.	Chairside Assisting - Oral Surgery & Pathology
6.	Preventive Dentistry	13.	Chairside Assisting - Other Specialties
7.	Ethics & Personal Development	14.	Expanded Duties

In this test, the number of mathematics questions is 1 percent and the number of science questions is 56 percent of the total number of questions. The mathematic questions emphasize basic mathematics and geometry. And the science questions emphasize physiology, anatomy, chemistry, physics, microbiology. There are several questions in psychology, botany and zoology.

Sample items.

Mathematics

The angulation used to x-ray the mandibar molar area is:

1. -20°.
2. -15°.
3. - 5°.
4. 35°.

Science

With the slab at the correct temperature, silicate cement should be mixed:

1. 15-30 seconds.
2. 30-45 seconds.
3. 46-60 seconds.
4. 60-90 seconds.

Test 17. Medical Assisting.

This test contains 13 subtests which are:

Part 1	Part 2
1. Personal Development	6. Sterilization
2. Body System	7. Laboratory Skills
3. Clinical Skills	8. E.K.G.
4. Medications	9. X-Ray
5. Medical Office Skills	10. Diet & Nutrition
	11. First Aid
	12. Medical Terminology
	13. Medical Office Computations

The mathematics questions are 6% and the science questions are 64% of the total questions in the test. All mathematics questions are basic mathematics. The science questions emphasize physiology, anatomy, microbiology, physics and chemistry.

Sample items.

Mathematics

You received a statement of medical supplies which included: 1 box of injectibles $ 38.00, a box of syringes $ 36.50, 1 gallon alcohol $ 2.60, 2 gallons distilled water at $ 1.29 each. The check for payment would be:

1. $ 74.50.
2. $ 78.39.
3. $ 79.68.
4. $ 81.58.

Science

The majority of disease-producing microorganisms require:

1. dryness, coolness and oxygen for growth.
2. moisture, warmth and oxygen for growth.
3. dryness, warmth and oxygen for growth.
4. moisture, coolness and an oxygen free environment for growth.

Test 18. Diversified Health Occupations.

The test consists of 11 subtests which are:

Part 1	Part 2
1. Anatomy & Physiology	6. Emergency first aid
2. Asepsis & Sterilization	7. Long Term Care Nursing
3. Vital Signs	8. Home Health Aide
4. Acute Care Nursing	9. Medical Assisting & Laboratory
5. Ward Clerk	10. Dental Assisting
	11. Personal Development, Employment Skills and Ethics

There are 4% mathematics questions and 63% science questions in the test. All mathematics questions are in the area of basic mathematics. The science questions are concentrated in physiology, micro-biology, anatomy, chemistry and physics.

Sample items.

Mathematics

You received a statement of medical supplies which included: 1 box of injectables $ 38.00, 1 box of syringes $ 36.50, 1 gallon alcohol $ 2.60, 2 gallons distilled water at $ 1.29 each. The check for payment would be:

1. $ 74.50.
2. $ 78.39.
3. $ 79.68.
4. $ 81.58.

Science

Insulin is secreted by

1. Adrenal Cortex.
2. Islets of Langerhans.
3. interior portion of the pituitary.
4. interior portion of thymus.

Home Economics Education

Test 19. Fabric Services

There are 15 subtests in this test. They are:

Part 1	Part 2
1. Alteration Specialist	8. Interior Design Specialist
2. Custom Dressmaker	9. Drapery Consultant
3. Custom Tailor	10. Drapery Maker
4. Fabric Coordinator	11. Drapery Installer
5. Fashion Coordinator	12. Slipcover Maker
6. Power Machine Operator	13. Upholsterer
7. Dry Cleaner	14. Refinisher
	15. Careers & Employment

The number of mathematics items is 6% of the total items of the test. The questions are concentrated in basic mathematics, and some questions are found in the area of geometry. The proportion of science items to the total number of items is 7%. Chemistry and physics are the subject matter areas where science questions are concentrated.

Sample items.

Mathematics

How many widths of 48" fabric would would be needed to make sheers for a window with 60" rods, 3" returns?

1. 2.
2. 3.
3. 4.
4. 5.

Science

Dry side agents used in dry cleaning included:

1. acidic acid and digester.
2. rust remover and ammonia.
3. paint remover and acetate.
4. synthetic detergent and ammonia.

Test 20. Home Economics Food Services

There are 10 subtests included in this test. They are:

Part 1	Part 2
1. Baker	6. Dining Room Service
2. Cook/Chef	7. Cafeteria Line
3. Pantry Worker	8. Sanitation and Safety
4. Caterer	9. Storeroom Operations
5. Dietary Aide	10. Careers & Employment

The proportion of mathematics questions to the total test questions is 5%. These items are concentrated in basic mathematics. The proportion of science questions to the total test questions is 17%. Microbiology, chemistry, psychology, physics, physiology are predominant subject areas for science questions. A couple of questions are found in the content area of botany.

Sample items.

Mathematics

A cake measuring 18" x 36" cut into 3" x 4" pieces will yield how many servings?

1. 48.
2. 54.
3. 60.
4. 72.

Science

Fermentation of yeast dough is accomplished by adding:

1. sugars.
2. leavenings.
3. shortenings.
4. salts.

Test 21. Community and Home Services

This test contains 15 subtests which are:

Part 1		Part 2	
1.	Personal Care for Patient	7.	Care of Cleaning Equipment
2.	Vital Signs	8.	Care of Furnishings
3.	Lift, Move, & Transport Patients	9.	Care of Resilient and Masonry Floors
4.	Perform Special Care	10.	Care of Draperies, Upholstery & Carpeting
5.	Infant & Child Care	11.	Provide Room Care
6.	Provide Food Service	12.	Care of Restrooms
		13.	Care of Public Areas
		14.	Provide Laundry Service
		15.	Careers & Employment

The percentage of mathematics questions is one. These questions are all basic mathematics. The percentage of science questions is 31%. The questions are concentrated in the subject matter areas of physiology, microbiology, chemistry, anatomy and psychology.

Sample items.

Mathematics

A linen storage shelf is 18" deep, 60" wide. Which folded bed sheet would fit neatly on the shelf?

1. 17"
   24"
2. 6"
   36"
3. 20"
   20"
4. 19"
   30"

Science

A patient condition that must be reported immediately is:

1. depressed attitude.
2. constipation.
3. changed eating habits.
4. breathing difficulty.

Test 22. Child Care Service.

There are 12 subtests included in this test. They are:

Part 1	Part 2
1. Child Care Career	8. Activity Selection
2. Center Administration	9. Structured Activity Preparation
3. Maintenance	10. Unstructured Activity Supervision
4. Program Planning	11. Routine Activity Supervision
5. Evaluation	12. Nutrition & Snacks
6. Special Needs Children	
7. Health & Safety	

There are 21% mathematics questions in this test, which are all in the area of basic mathematics. The percentage of science questions is 56. These questions are concentrated in the area of psychology and physiology. Some science questions are found in the areas of chemistry, microbiology, physics, botany, zoology and anatomy.

Sample items.

Mathematics

You are responsible for collecting $ 1.35 each from a class of twenty-three children for a special assembly. Four of the children did not pay. How much money did you turn into the office?

1. $ 20.25.
2. $ 25.65.
3. $ 26.25.
4. $ 35.65.

Science

A child's language development can be best evaluated by observing children:

1. in parallel play.
2. talking together.
3. listening to a story.
4. singing in a group.

Trade and Industrial Education

Test 23. Auto Body Mechanics.

There are 14 subtests in this test which are:

Part 1	Part 2
1. Welding	7. Trim and Hardware
2. Repair and Strengthen	8. Glass Replacement
3. Patch and Fill	9. Frame and Unit Body Repair
4. Fiberglass Repair	10. Suspension Systems
5. Panel Replacement	11. Engine Cooling Systems
6. Refinishing	12. Air Conditioning
	13. Electrical System
	14. Shop Management and Operations

The number of mathematics items is 7 % of the total number of items on the test. The questions are concentrated in basic mathematics. Several questions are found in the area of geometry. The number of science questions is 23 % of the total questions. These questions are concentrated in physics and chemistry.

Sample items.

Mathematics

Four gallons of plastic filler cost $ 30.00, what is the cost per pint?

1. $ 7.50
2. $ 3.75.
3. $ 1.88.
4. $ .94.

Science

Oxyacetylene cutting is a process of:

1. blowing.
2. melting.
3. oxidizing.
4. melting and blowing.

Test 24. Automotive Mechanics.

This test contains 16 subtests which are:

Part 1	Part 2
1. Service Management	8. Charging Systems
2. Lubrication & Prevention Maintenance	9. Accessory Systems
3. Engine Service Repair	10. Transmissions
4. Cooling System	11. Drive Line
5. Fuel & Exhaust Systems	12. Emission Systems
6. Ignition Systems	13. Brake Systems
7. Cranking System	14. Steering Systems
	15. Suspension Systems
	16. Heating, Ventilation & Air Conditioning

There are 12% mathematics questions on the test. These qeustions are concentrated in basic mathematics. Some questions are found in the area of geometry. The percentage of science questions is 34. These questions are concentrated in the area of physics and chemistry.

Sample items.

Mathematics

A repair job required 8¼ days. At $ 48.40 per day, what was the total labor cost?

1. $ 398.60.
2. $ 399.50.
3. $ 399.30.
4. $ 398.30.

Science

The best time to drain engine oil is:

1. when the engine is hot.
2. when the filter is dirty.
3. after setting overnight.
4. during a tune-up.

Test 25. Small Engine Repair.

There are 15 subtests included in this test. They are:

Part 1	Part 2
1. Tools and Fasteners	8. Ignition Systems
2. Fuel & Exhaust Systems	9. Valve Train Systems
3. Cooling & Lubrication Systems	10. Troubleshooting
4. Short Block & Governor Systems	11. Lawn and Garden Equipment
5. Charging & Electrical Systems	12. Motorcycle Equipment
6. Starting System	13. Marine Equipment
7. Mechanics Mathematics	14. Snowmobile Equipment
	15. Business and Shop Operation

There are 12% mathematics questions in this test. These questions are concentrated in basic mathematics and geometry. There are 23% science questions included in the test. The questions are concentrated in physics and chemistry.

Sample Items.

Mathematics

If the pinion has 14 teeth and the ring gear has 63 teeth, what is the rear axle ratio?

1. 3.56 : 1.
2. 4.5 : 1.
3. 4.7 : 1.
4. 4.11 : 1.

Science

The instrument used to check the armature for a possible ground is:

1. a voltmeter.
2. a micrometer.
3. an ohmmeter.
4. a caliper.

Test 26. Diesel Mechanics.

There are 14 subtests in this test which are:

Part 1	Part 2
1. Service & Repair Engine	7. Cooling Systems
2. Fuel Systems	8. Drive Line
3. Intake Systems	9. Steering Systems
4. Charging & Cranking Systems	10. Brake Systems
5. Electrical & Ignition Systems	11. Suspension Systems
6. Hydraulic Systems	12. Heating & Air Conditioning System
	13. Lubrication & Preventive Maintenance
	14. Service Management

The number of mathematics questions is 5% of total questions in the test. The questions are concentrated in basic mathematics and geometry. The percent of science questions to total questions is 18%. These questions are concentrated in physics and chemistry.

Sample Items.

Mathematics

The long end of a leaf spring is 21-7/16". What is the length of the short end if the overall length is 33-1/2"?

1. 11-7/16".
2. 12-1/16".
3. 12-1/8".
4. 13-1/8".

Science

Some valves are cooled by partially filling their hollow stem with:

1. water.
2. sodium.
3. calcium.
4. hydrogen.

Test 27. Carpentry.

This test contains 11 subtests which are:

Part 1	Part 2
1. Blueprint Reading	8. Roof Framing
2. Surveying	9. Roofing
3. Foundation	10. Exterior Finish
4. Floor Framing	11. Interior Finish
5. Wall & Ceiling Framing	
6. Insulation	
7. Mathematics & Estimating	

The number of mathematics questions is 25% of the total number of questions in this test. These questions are concentrated in the area of basic mathematics and geometry. The number of science questions is 12% of the total questions. The predominant content area where science questions are concentrated is physics.

Sample Items.

Mathematics

How many ceiling joists would be needed for a 28' x 56' gable roof using 14' ceiling joists at 16" o.c.?

1. 43 joists.
2. 56 joists.
3. 86 joists.
4. 112 joists.

Science

The nails used to fasten aluminum soffit material should be:

1. screw nails.
2. galvanized nails.
3. stainless steel nails.
4. aluminum nails.

Test 28. Construction Electricity.

There are 11 subtests included in this test. They are:

Part 1	Part 2
1. Basic Electricity	6. Safety
2. National Electric Code	7. Service Entrance
3. Planning and Layout	8. Motors and Controls
4. Rough-in Wiring	9. Low-Voltage Systems
5. Finish Wiring	10. Electrician's Mathematics
	11. Personal Development

The number of mathematics questions is 16% of the total questions in the test. The questions are concentrated in the area of basic mathematics. The proportion of science questions to total questions is 29%. These questions are predominantly concentrated in the area of physics.

Sample items.

Mathematics

In a transformer, the primary to secondary turns ratio is 3:1, if the primary voltage is 600 V the secondary voltage is:

1. 200 V.
2. 300 V.
3. 1800 V.
4. 1200 V.

Science

Thermal insulation refers to:

1. noise reduction.
2. sound transmission.
3. heat loss prevention.
4. moisture prevention.

Test 29. Heating, Air Conditioning and Refrigeration

There are six subtests in this test. They are:

Part 1		Part 2	
1.	Installing Refrigeration & Air Conditioning Equipment	3b.	Service & Repair Refrigeration & Air Conditioning Equipment--Mechanical
2a.	Troubleshooting Refrigeration & Air Conditioning Equipment--Electrical	4.	Installing Warm Air Heating Systems
2b.	Troubleshooting Refrigeration & Air Conditioning Equipment--Mechanical	5a.	Troubleshooting Warm Air Heating --Electrical
3a.	Service & Repair Refrigeration & Air Conditioning Equipment--Electrical	5b.	Troubleshooting Warm Air Heating Sytem--Mechanical
		6a.	Service & Repair Warm Air Heating System--Electrical
		6b.	Service & Repair Warm Air Heating System--Mechanical

The number of mathematics questions is 2% of the total number of items in this test. The questions are concentrated in the areas of basic mathematics and geometry. The number of science questions is 25% of the total questions. Physics and chemistry are the predominant content areas where science questions are found.

Sample Items.

Mathematics

The number of 6" square pieces that can be cut from a 24" x 8' galvanized sheet is:

1. 60.
2. 64.
3. 32.
4. 96.

Science

The electrical power outlet for a unit may be checked by:

1. an ammeter.
2. a test light.
3. a wattmeter.
4. an ohmmeter.

Test 30. Masonry

There are 10 subtests included in this test.

Part 1	Part 2
1. Prepare Materials & Job Site	6. Miscellaneous Masonry Construction
2. Lay Brick and Block to a Line	7. Concrete Masonry
3. Lay Brick and Block with a Plumb	8. Surveying
4. Fireplaces and Chimneys	9. Mathematics and Blueprint Reading
5. Arches	10. Personal Development

This test consists of 8 percent mathematics questions. These questions are concentrated in the areas of basic mathematics and geometry. The proportion of science questions to the total items of the test is 6 percent. And these questions are concentrated in the areas of physics. Several questions are found in the areas of chemistry and psychology.

Sample items.

Mathematics

A fireplace 6'4" wide is built in a room that has an inside measurement of 11'2" along one wall. The length of the remaining space is:

1. 2'5".
2. 4'10".
3. 5'10".
4. 17'6".

Science

To prevent shock, an electrically powered mortar mixer must be:

1. wired.
2. elevated.
3. grounded.
4. insulated.

Test 31. Communication Product Electronics.

This test consists of 13 subtests. They are:

Part 1	Part 2
1. Personal Development	7. Audio Systems
2. D.C. Electronics	8. Radio Receiver Systems
3. A.C. Electronics	9. T.V. Receiver Systems
4. Active Electronic Devices	10. Transmitter Systems
5. Electronic Circuitry	11. Antenna and Transmission Systems
6. Electronic Test Equipment	12. Special Systems
	13. Digital Logic System.

There are 22 percent mathematics questions included in this test. These questions are in basic mathematics and algebra. The number of science questions is 76 percent of the total number of questions in this test. Physics is the predominant area of content where science questions are found.

Sample items.

Mathematics

The answer to the following binary subtraction problem in binary is:

$$\begin{array}{r} 11011010 \\ - \ 10101101 \end{array}$$

1. 00101101_2
2. 10000111_2
3. 00101100_2
4. 10101101_2

Science

The core material of an electromagnet must have a high:

1. hysteresis.
2. reluctance.
3. retentivity.
4. permeability.

Test 32. Industrial Electronics.

This test has 13 subtests included in two parts. The subtests are as follows:

Part 1	Part 2
1. Personal Development	8. Analog Electronic Circuits
2. Selling, Installing & Testing Equipment	9. Digital Logic
3. Fabricate Circuits and Enclosures	10. Digital Electronic Circuits
4. D.C. Electronics	11. Troubleshooting & Analysis
5. A.C. Electronics	12. Special Electronic Devices
6. Semi-Conductors	13. Electro-Mechanical Devices
7. Test Equipment	

The proportion of mathematics questions to the total number of questions in this test is 26 percent. The questions are concentrated in the areas of basic mathematics and algebra. There are some questions in geometry. The proportion of science questions is 79%. These questions are concentrated in physics. There is also one question in psychology and one in chemistry.

Sample items.

Mathematics

The circular mil area of a 1/8" diameter wire is:

1. 250 mils.
2. 15625 CM.
3. 125 CM.
4. 15625 mils.

Science

The symbol illustrated below is a :

1. thermocouple.
2. transresistor.
3. thermistor.
4. photo resistor.

Test 33. Commercial Art.

The test consists of 10 subtests as follows:

Part 1	Part 2
1. Drawing	6. Drafting
2. Design	7. Mechanical
3. Illustration	8. Photography
4. Technique	9. Layout
5. Color	10. Typography

The number of mathematics question is 13 percent of the total number of all items. Geometry and basic mathematics are two areas where mathematics questions are concentrated. The proportions of science questions to the total number of questions in the test is 74 percent. The questions are concentrated in the areas of physics and chemistry. There are few questions in the areas of microbiology and psychology.

Sample items.

Mathematics

A flat surface in drawing and illustration is referred to as:

1. trapezoid.
2. plane.
3. rectangle.
4. plate.

Science

Light that bounces from another surface onto the object the artist is drawing is referred to:

1. diffused light.
2. suffused light.
3. reflected light.
4. indirect light.

Test 34. Drafting.

This test consists of the 17 following subtests:

Part 1	Part 2
1. Geometric Drawing	11. Intersections and Developments
2. Orthographic Projection	12. Mechanisms
3. Pictorial Drawing	13. Architectural Drawings
4. Sectional Views	14. Structural Drawings
5. Auxilliary Views	15. Electrical Drawing
6. Drafting Materials, Equipment & Reproduction Methods	16. Civil Engineering Drawings
7. Dimensioning	17. Personal Development
8. Production/Working Drawings	
9. Fastening Methods	
10. Industrial Materials and Processes.	

This test contains 40 percent of mathematics questions which are concentrated in geometry and basic mathematics. A few questions are found in the area of trigonometry. The proportion of science questions is 20 percent of the total questions. These questions are concentrated in the areas of physics and chemistry. Some questions are found in the area of geology.

Sample items.

Mathematics

Drawing an angle of 75 requires the use of:

1. a combination of 30-60 and 45 triangles.
2. two 30-60 triangles.
3. two 45 triangles.
4. a combination of 15 and 30-60 triangles.

Science

The light exposure time required in the ammonia process is not affected by the:

1. type of tracing paper.
2. developing solution.
3. speed of print paper.
4. intensity of light.

Test 35. Lithographic Printing.

This test contains the 10 following subtests:

Part 1	Part 2
1. Layout and Designs	7. Stripping
2. Composing	8. Platemaking and Proofs
3. Proofing	9. Offset Presses
4. Paste-up	10. Finishing Operations
5. Camera and Film Processing	
6. Personal Development	

The proportion of mathematic questions is 12 percent. These questions are concentrated in basic mathematics. Some questions are found in the area of geometry. The proportion of science questions in this test is 15 percent. The questions are concentrated in the areas of physics and chemistry.

Sample items.

Mathematics

A piece of artwork 20 picas x 20 picas is marked 150%. What is the desired size?

1. 25 x 25 picas.
2. 30 x 30 picas.
3. 35 x 35 picas.
4. 40 x 40 picas.

Science

One of the light sources used to expose phototypesetting characters is:

1. laser.
2. CRT.
3. VDT.
4. raster.

Test 36. Machine Trades.

This test contains 11 subtests. They are:

Part 1	Part 2
1. Benchwork	6. Layout and Blueprint
2. Inspection and Measuring Instruments	7. Milling
3. Drilling Machines	8. Abrasive Maching
4. Turning Machines	9. Heat Treating & Applied Sciences
5. Sawing and Special Operations	10. N.C./C.N.C.
	11. Personal Development

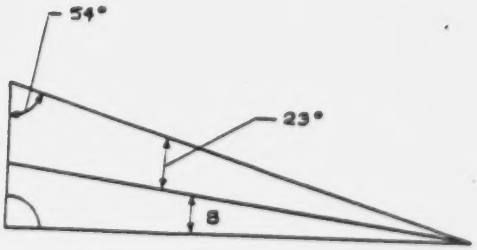
The number of mathematic questions is 15 percent of the total number of questions in the test. These mathematics questions are concentrated in basic mathematics and geometry. A few questions are found in the area of trigonometry. The proportion of science questions in this test is 6 percent. Chemistry and physics are two subject matter areas where science questions are found.

Sample items.

Mathematics

In the drawing below, the number of degrees in angle B is:

1. 9°.
2. 13°.
3. 31°.
4. 7°.



Science

The ratio of the output to the input of any machine in the shop is called:

1. horsepower.
2. efficiency.
3. work.
4. velocity.

Test 37. Welding.

This test consists of the 7 following subtests:

Part 1	Part 2
1. Labor and Management	4. Tungsten Arc Welding
2. Oxyacetylene Welding	5. Gas Metal Arc Welding
3. Shieded Metal Arc Welding	6. Resistance Welding
	7. Blueprint and Math.

The test contains 12 percent mathematics questions which are in the areas of basic mathematics and geometry. The number of science questions is 20 percent of total number of questions in the test. The science questions are concentrated in the areas of chemistry and physics.

Sample items.

Mathematics

The angle at which the T.I.G. welding torch should be in relation to the base metal is:

1. 20° to 25°.
2. 30° to 40°.
3. 50° to 60°.
4. 70° to 80°.

Science

After aluminum oxide has been removed from aluminum, it starts to reform:

1. within weeks.
2. within hours.
3. within days.
4. immediately.

Test 38. Cosmetology.

This test contains the 10 following subtests:

Part 1	Part 2
1. Sanitation	7. Permanent Waving
2. Scalp Care	8. Hair Coloring
3. Manicure	9. Applied Science
4. Hair Shaping	10. Shop Management & Mathematics.
5. Hair Styling	
6. Facial	

The test consists of 3 percent mathematics questions. These questions are concentrated in basic mathematics and geometry. The proportion of science questions in this test is 65 percent. Chemistry, physiology, microbiology, botany and physics are the subject matter areas where the science questions are concentrated. There are some questions found in the area of anatomy.

Sample items.

Mathematics

A patron purchases $ 12.50 worth of retail items plus 4% tax, a nontaxable permanent wave service costing $27.50 and leaves the operator a 15% tip on the service only. The total cost to the patron will be:

1. $ 40.50.
2. $ 44.13.
3. $ 44.63.
4. $ 45.90.

Science

Shampoos with a high alkaline content will:

1. close the cuticle.
2. give the hair luster.
3. damage the hair.
4. strengthen the cortex.

Part II Performance Levels on Mathematics, Science and SFTAA of Students in Vocational Education

Part II Performance Levels on Mathematics, Science, and SFTAA of Students in Vocational Education

The purpose of this portion of the report focuses on achievement of students enrolled in vocational education in mathematics and science on the 38 Vocational Education Achievement Tests taken in 1985. The performance of students in mathematics and science is illustrated by two indicators: the mean percentages of correctly answered mathematics and science questions by students, and the raw score variation of scores on mathematics and science.

In addition to the achievement indicators in science and mathematics, in each vocational area, a common indicator of academic aptitude was obtained from each participant. The SFTAA scores for students in each program are presented.

With respect to the overall performance of the juniors and seniors on the Ohio Vocational achievement tests, each test was designed such that there was an average item difficulty of about 50% i.e., about 50% of the students taking each question would get the item correct. For psychometric reasons, this gives the assessment tool maximum ability to discriminate between those who know the content and those that do not. As a result of the way the test is constructed, student performance is generally expected to be at about the 50% correct level for each test. This factor should be kept in mind as one interprets the results presented in this report.

(1) The Mean Percentages of Correctly Answered Questions by Students.

In order to document the performance level in mathematics and science of the students in a vocational education program, the mean percentage of correctly answered mathematics and science questions in 38 Vocational Education Achievement Tests were calculated for juniors and seniors. Tables 2-13 show the total number of students who took the tests. In addition, the

average performance of students correctly answering the composite of all mathematics and science questions are presented. The mean performances are also summarized by vocational program areas in Figures 1 through 16 to compare the level of performance in mathematics and science of the juniors and seniors who enrolled in vocational education.

Table 2

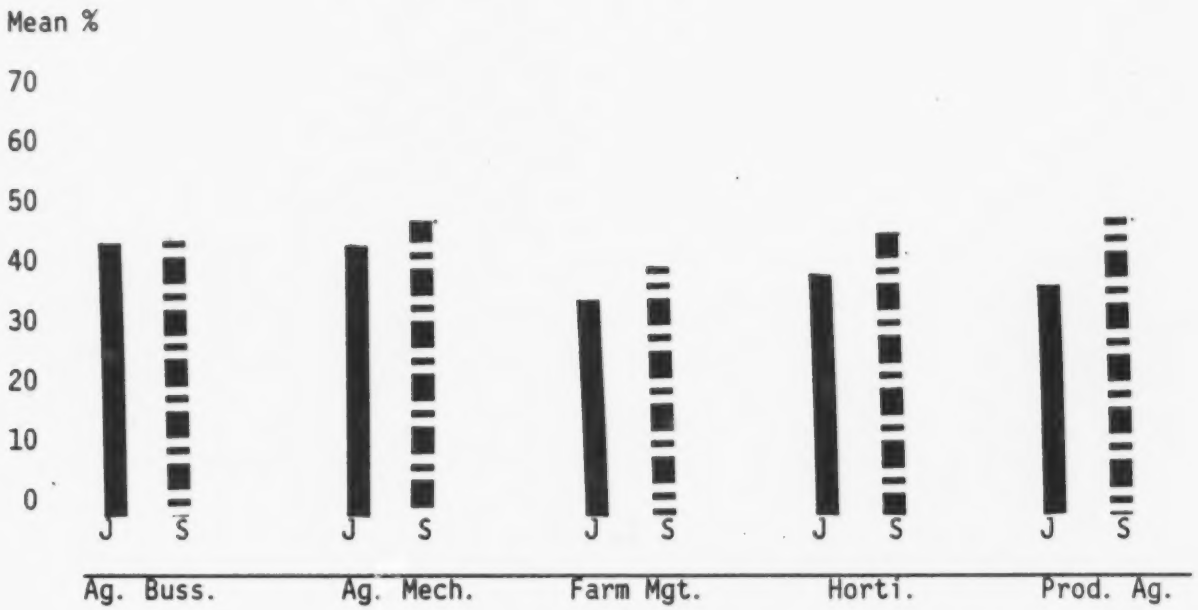
Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Agricultural Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Agricultural Business	158	68	40.80	41.71	41
2) Agricultural Mechanics	522	656	40.82	46.06	20
3) Farm Management	66	59	31.19	39.95	80
4) Horticulture	446	384	38.36	43.00	14
5) Production Agriculture	68	121	37.57	46.40	20

Table 2 shows the total number of students in agricultural education who took the Vocational Education Achievement Tests and the mean percentages of juniors and seniors who correctly answered mathematics questions in the tests. Illustrated in Table 2 and Figure 1, juniors scored 41% and seniors scored 46% in Agricultural Mechanics, juniors scored 31% and seniors scored 40% in Farm Management, juniors scored 40% and seniors scored 43% in Horticulture, juniors scored 38% and seniors scored 56% in Production Agriculture on mathematics questions in the respective tests. Obviously, the mean percentages of the seniors were higher than their junior counterparts. However, the mean

Figure 1

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Agricultural Education



percentages of the juniors and seniors in Agricultural Business were 41 and 42 respectively which are only slightly different. In general, seniors outperformed juniors in Agricultural Education with respect to performance on mathematics questions. All students answered less than 50% of the items correctly.

From Table 3 and Figure 2, juniors scored 38% and seniors scored 47% in Accounting and Computing Clerk, juniors scored 36% and seniors scored 41% in Clerk Typist, juniors scored 45% and seniors scored 53% in Clerk Stenographer, juniors scored 46% and seniors scored 58% in Data Processing, juniors scored 43% and seniors scored 46% in General Office Clerk, juniors scored 52% and

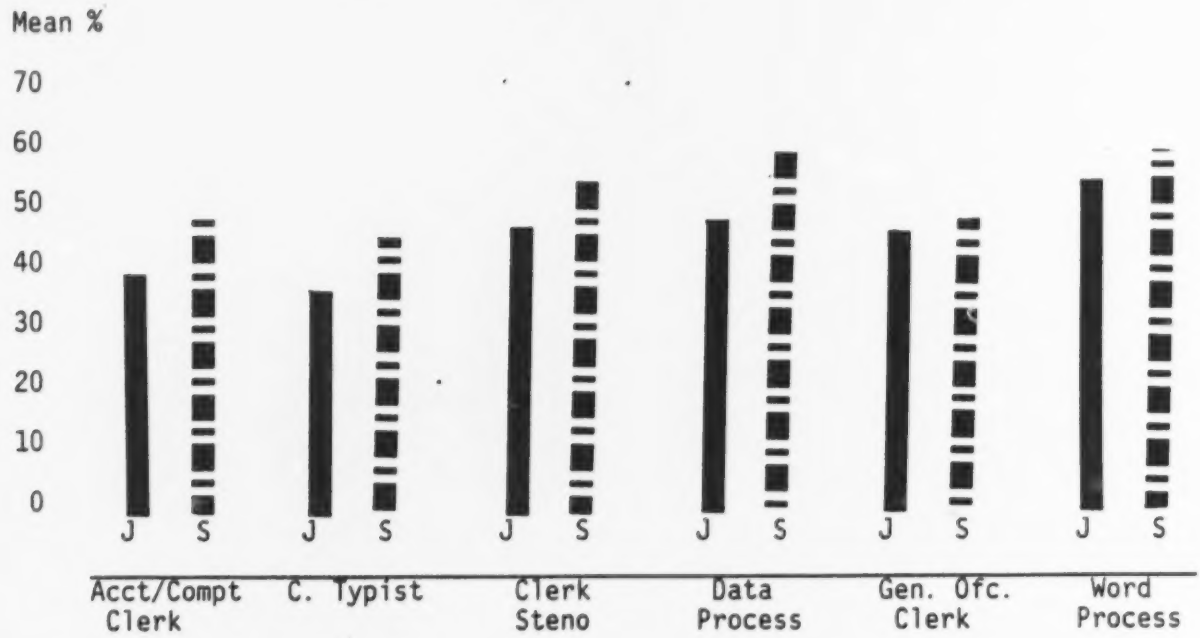
Table 3

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Business Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Accounting/Computing Clerk	1,205	926	38.36	47.03	47
2) Clerk Typist	624	502	35.86	40.62	23
3) Clerk Stenographer	1,717	1,430	44.95	52.81	24
4) Data Processing	1,025	982	46.33	57.59	33
5) General Office Clerk	1,251	916	43.02	45.94	26
6) Word Processing	497	331	51.79	56.43	15

Figure 2

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Business Education



seniors scored 56% in Word Processing on the respective mathematics questions in the Vocational Education Achievement Tests. Obviously, the mean percentages of seniors were higher than those of the juniors in every program. In general, the seniors correctly answered approximately half of the math items while the juniors answered less than half of the items correctly.

Table 4

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Marketing Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Apparel & Accessory	70	29	59.54	61.76	22
2) D.E. Food Service Personnel	85	36	44.64	38.42	18
3) Food Marketing	129	61	40.94	40.38	38
4) General Merchandizing	1,252	673	40.55	42.84	37

Figure 3

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Marketing Education

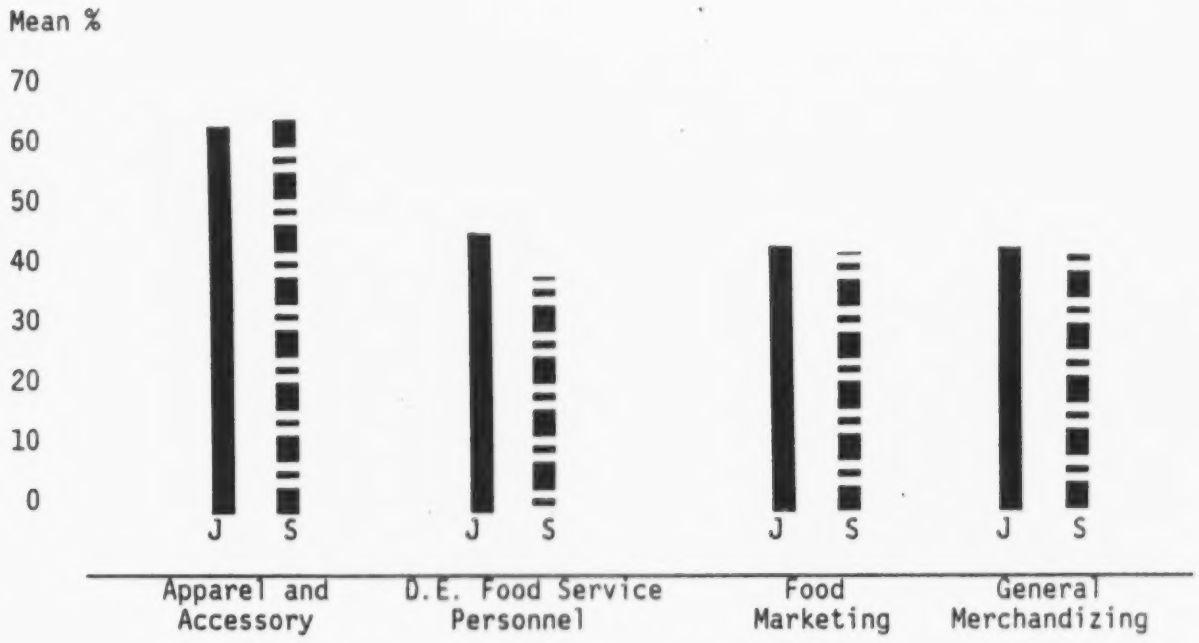


Table 4 illustrates the total number of vocational students in Marketing Education, who took the Vocational Education Achievement Tests and the mean percentages of mathematics questions correctly answered by students. Juniors scored 60% and seniors scored 62% in Apparel and Accessories, juniors scored 45% and seniors scored 38% in D.E. Food Service Personnel, juniors scored 41% and seniors scored 40% in Food Marketing, juniors scored 61% and seniors scored 43% in General Merchandising on the mathematics questions. In general, the performance of both groups was less than 50% except for the Apparel and Accessory test.

From Figure 3, the bar graph illustrates that the mean performance of seniors in Apparel and Accessories and General Merchandising were slightly higher than those of the juniors in the same programs. However, the mean performance of the seniors was slightly lower than juniors in D.E. Food Service Personnel and Food Marketing.

Table 5 shows the number of students in Health Occupations Education who took the Vocational Education Achievement Tests and the mean performance of students who correclty answered mathematics questions in the tests. Juniors scored 39% and seniors scored 46% in Dental Assisting, juniors scored 48% and seniors scored 50% in Diversified Health, and juniors scored 42% and seniors scored 54% in Medical Assisting on the mathematics questions. Figure 4 illustrates that the mean performances of seniors were higher than those of the juniors in all three programs. In general, the overall performance of the seniors was approximately at the 50% current level with juniors performing at a slightly lower level.

Table 5

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Health Occupation Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Dental Assisting	342	297	38.95	46.40	5
2) Medical Assisting	138	126	42.29	53.68	22
3) Diversified Health	693	580	48.00	49.74	15

Figure 4

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Health Occupations Education

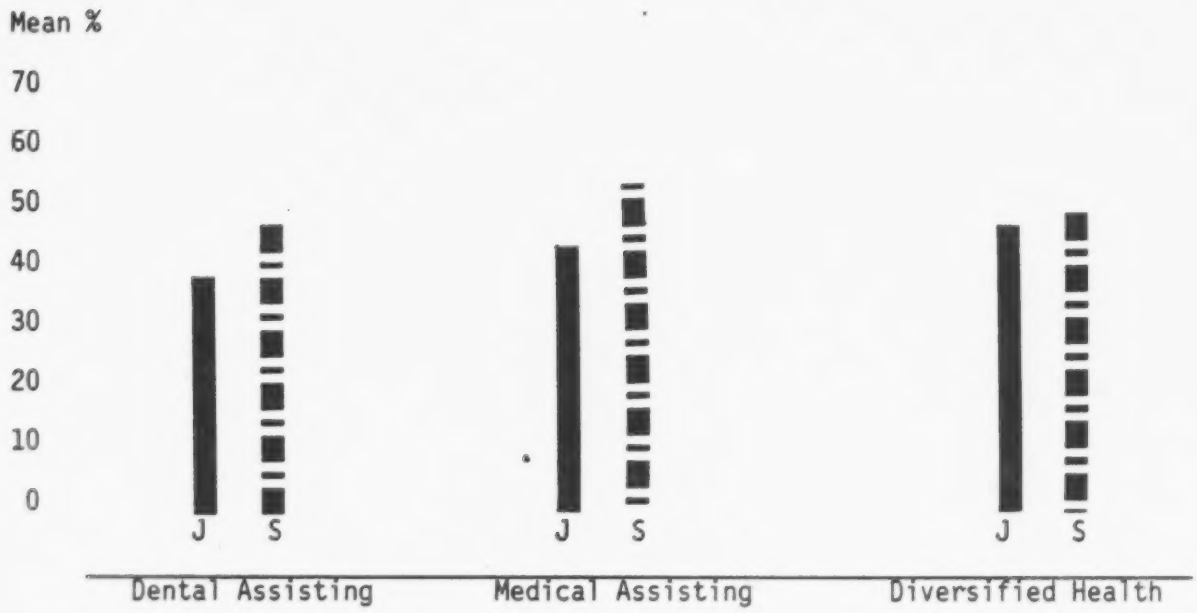


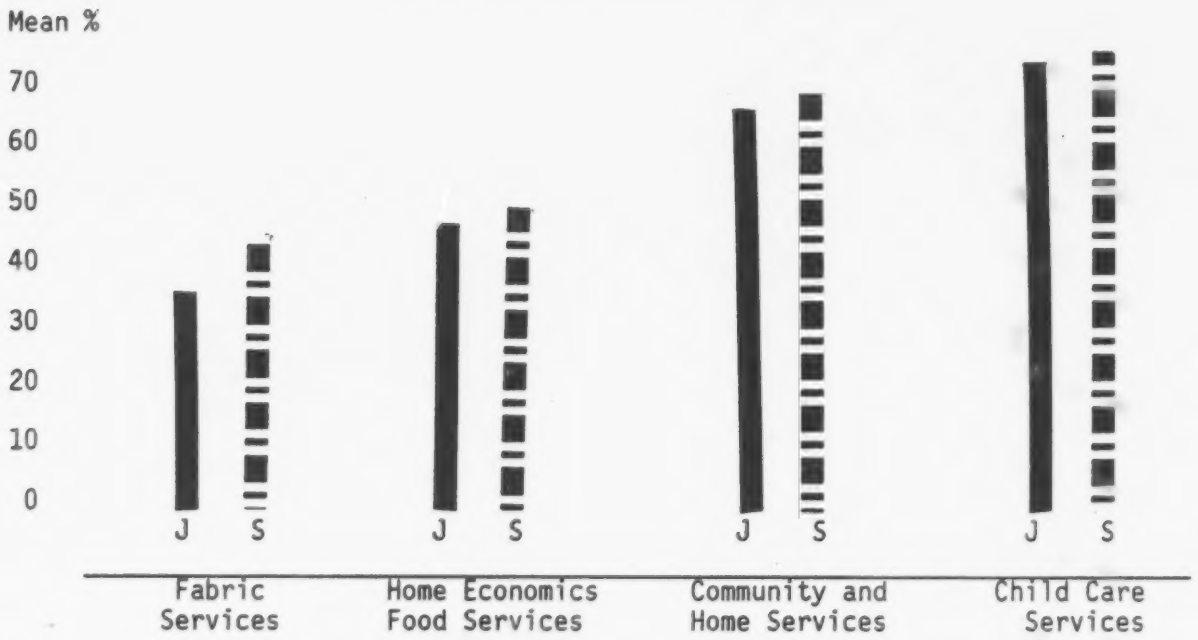
Table 6

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Home Economics Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Fabric Services	137	85	32.91	44.76	22
2) Home Economics Food Service	766	676	47.11	49.30	20
3) Community and Home Service	162	96	66.82	69.55	4
4) Child Care Services	624	484	73.60	74.80	5

Figure 5

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Home Economics Education



Illustrations in Table 6 and Figure 5 shows that juniors scored 33%, and seniors scored 45% in Fabric Services in correctly answering the mathematics questions in the Vocational Education Achievement Tests. However, the mean performance of the juniors in Home Economics Food Services, Community and Home Services and Child Care Services were 47%, 67%, and 74% respectively, whereas scores for the seniors were 49%, 70%, and 75% respectively. The mean performance of the seniors in these three programs were slightly higher than those of their junior counterparts. Note that the students correctly answered about 3/4 of the items in the Home Services and Child Care Service tests.

Table 7 shows the total number of students, both juniors and seniors, in 16 programs of Trade and Industrial Education who took the Vocational Education Achievement Tests, and the mean performance of the juniors and seniors who correctly answered the mathematics questions. Illustrated in

Figures 6 through 8, the average performance of seniors is higher than that of the juniors in almost every program. In Commercial Art, the mean performance of the seniors was only slightly higher than that of the juniors. In general the average percent correct for the seniors was 50% or less. The performance of the juniors was somewhat below that figure.

Table 7

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Trade and Industrial Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Auto Body Mechanics	1,083	1,061	35.02	40.15	251
2) Automotive Mechanics	1,717	1,648	36.61	43.29	38
3) Carpentry	767	907	38.94	49.34	81
4) Commercial Art	309	307	47.51	50.29	41
5) Communication Products Electronics	764	714	34.25	38.45	76
6) Construction Electricity	500	514	42.27	52.91	55
7) Cosmetology	1,593	1,614	48.30	55.68	9
8) Diesel Mechanics	331	390	43.70	48.71	16
9) Drafting	578	827	41.50	46.17	121
10) Heating, Air Cond. and Refrig.	291	286	39.83	45.00	6
11) Industrial Electronics	478	446	37.68	48.52	84
12) Lithographic Printing	482	499	33.74	39.81	43
13) Machine Trade	901	1,911	47.41	56.29	57
14) Masonry	202	205	34.85	46.96	23
15) Small Engine Repair	181	150	47.15	55.45	40
16) Welding	938	1,075	39.75	49.79	40

Figure 6

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Trade and Industrial Education

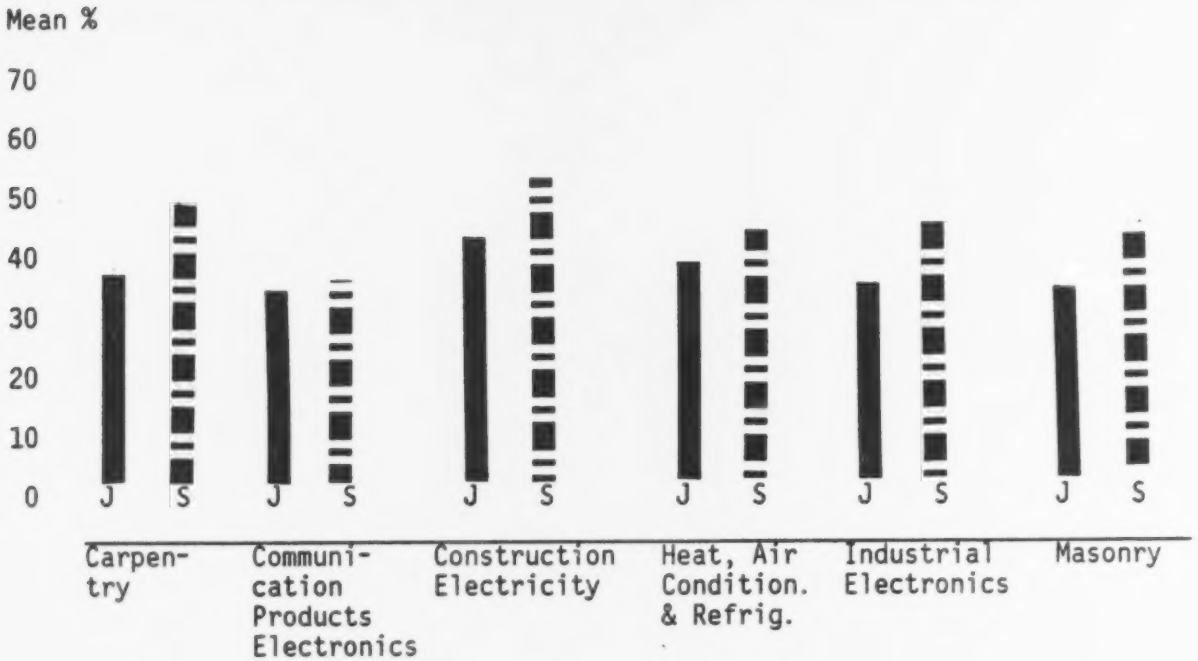


Figure 7

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Trade and Industrial Education

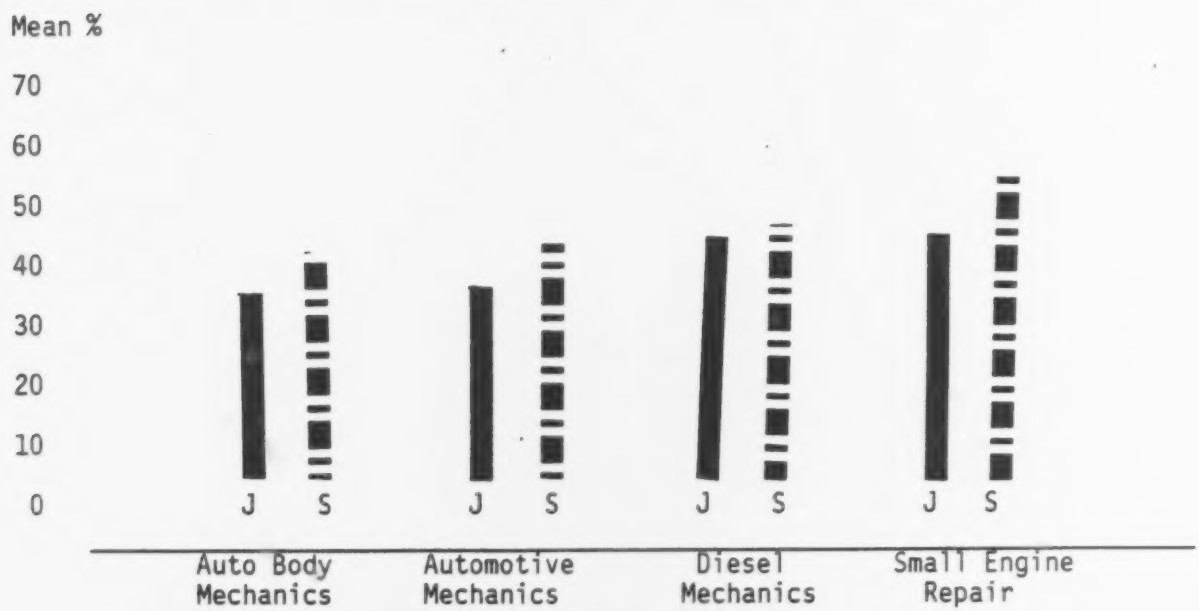


Figure 8

Mean Percentages of Mathematics Questions Correctly Answered by Juniors and Seniors in Trade and Industrial Education

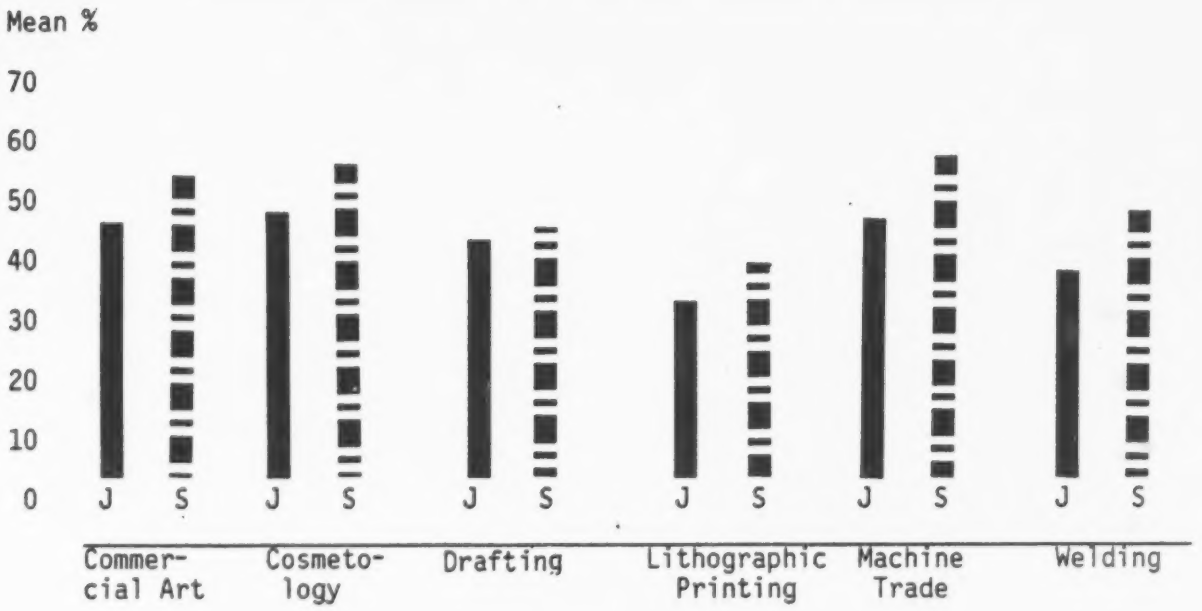


Table 8 indicates the total number of students who participated in the Vocational Education Achievement Tests and the Mean Percentages of science questions answered correctly by juniors and seniors. Juniors scored 37% and seniors scored 47% in Agricultural Business, juniors scored 41% and seniors scored 48% in Agricultural Mechanics, juniors scored 37% and seniors scored 48% in Farm Management, juniors scored 40% and seniors scored 47% in Production Agriculture on the various science test questions. Figure 9 illustrates a higher percentages of seniors than juniors in every program with seniors scoring just under 50% on the average and juniors scoring 40% or less on the average.

Table 8

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Agricultural Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Agricultural Business	158	68	37.12	44.23	40
2) Agricultural Mechanics	522	565	40.67	47.50	74
3) Farm Management	66	59	36.65	47.87	37
4) Horticulture	446	384	39.80	45.77	92
5) Production Agriculture	68	121	40.74	47.18	85

Figure 9

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Agricultural Education

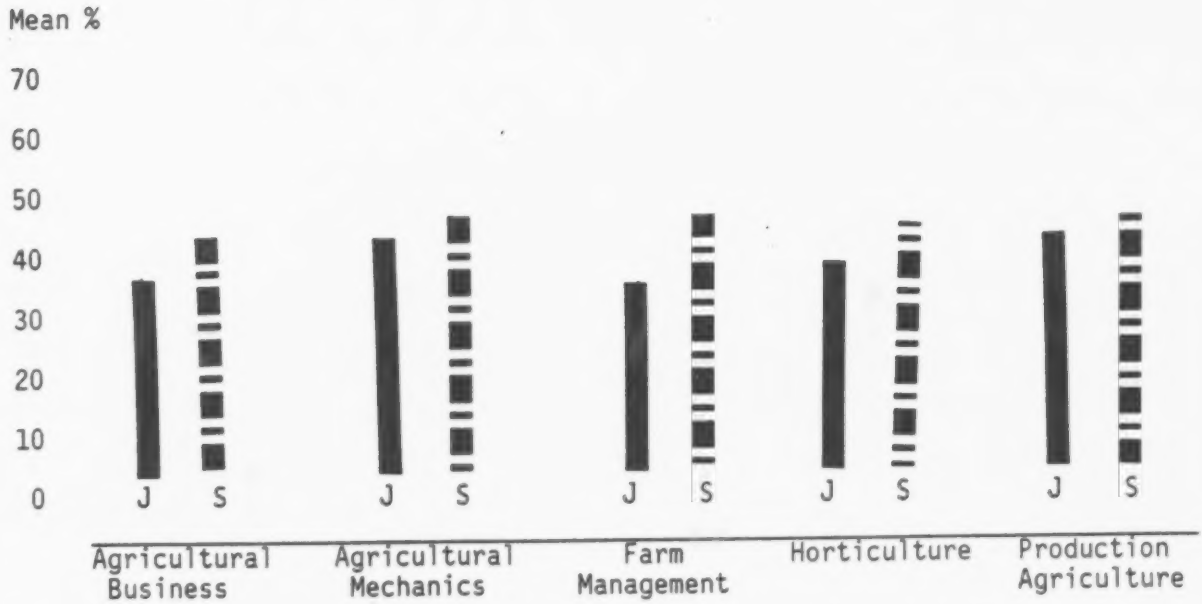


Table 9 shows the number of students in Business Education who took the Vocational Education Achievement Tests and the mean percentages of correctly answered science questions by juniors and seniors. Juniors scored 52% and seniors scored 58% in Accounting and Computing Clerk, juniors scored 42%, seniors scored 45% in Clerk Typist, juniors scored 51%, and seniors scored 59% in Data Processing, juniors scored 46% and seniors scored 48% in General Office Clerk, and juniors scored 56% and seniors scored 66% in Word Processing on correctly answered science questions. Figure 10 illustrates that the mean percentages of questions correctly answered by seniors were higher than those of juniors in every program. Percentages for the seniors was above 50% except for Clerk Typist and General Office Clerk.

Table 9

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Business Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Accounting and Computing Clerk	1,205	967	51.70	58.18	5
2) Clerk Typist	624	502	41.87	45.37	4
3) Clerk Stenographer	1,717	1,430	50.86	56.09	10
4) Data Processing	1,025	982	49.25	59.15	264
5) General Office Clerk	1,251	916	45.83	48.39	7
6) Word Processing	497	331	56.24	65.55	42

Figure 10

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Business Education

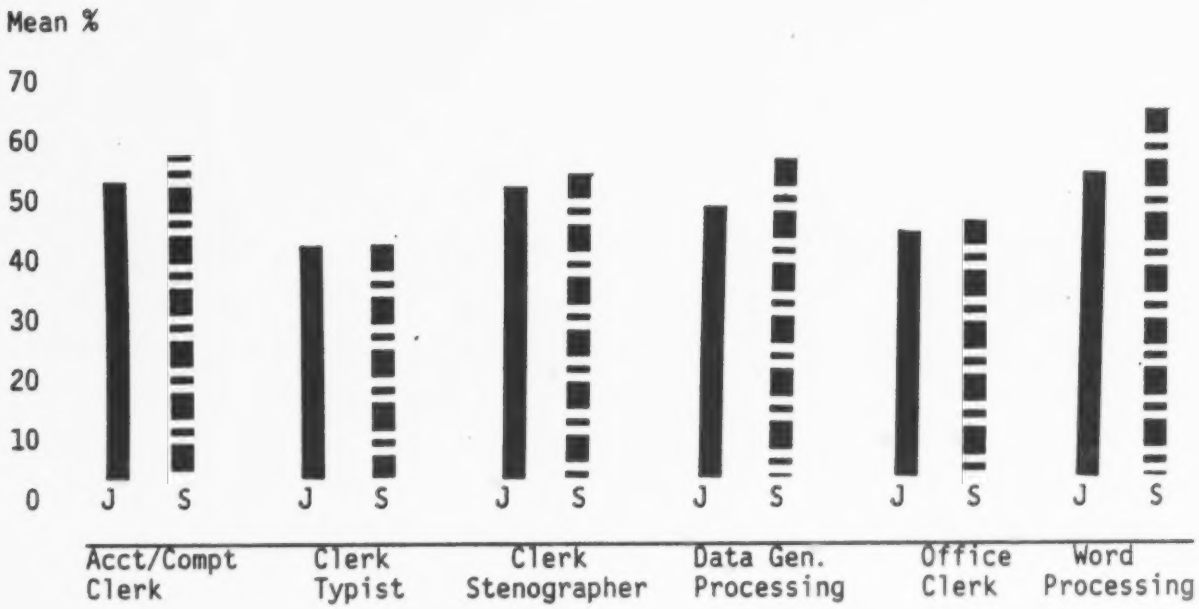


Table 10 presents the number of juniors and seniors in Marketing Education who took the Vocational Education Achievement Tests and the mean percentages of correctly answered science questions by the students. The juniors scored 69% and seniors scored 59% in Apparel and Accessories, juniors scored 46%, and seniors scored 48% in D.E. Food Service Personnel, juniors scored 44% and seniors scored 43% in Food Marketing, juniors scored 54% and seniors scored 56% in General Merchandising on the science questions. According to Figure 11, slightly more questions were answered correctly by seniors than juniors in Food Service Personnel and General Merchandizing. However, the performance of the juniors was higher than the seniors in Food Marketing and Apparel and Accessories. The performance of both juniors and senior was around the 50% mark except for the Apparel and Accessories tests.

Table 10

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Marketing Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Apparel & Accessories	70	29	69.29	58.62	2
2) D.E. Food Service Personnel	85	36	45.92	47.70	31
3) Food Marketing	129	61	44.44	42.72	15
4) General Merchandising	1,252	673	54.15	56.44	13

Figure 11

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Marketing Education

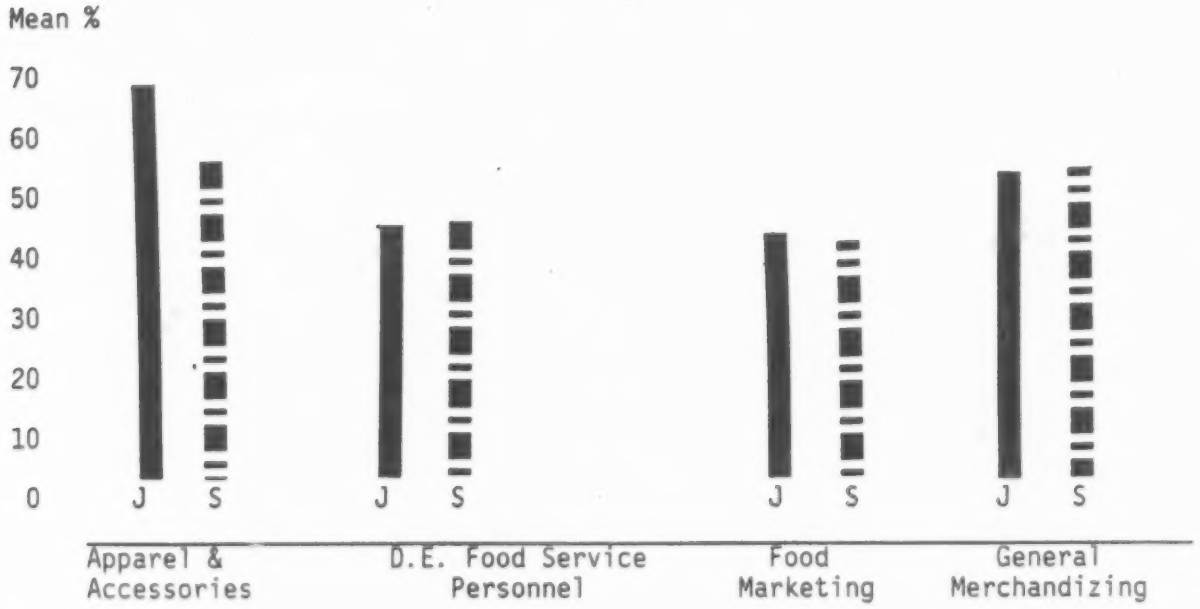


Table 11

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Health Occupations Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Dental Assisting	342	297	49.21	55.56	192
2) Medical Assisting	138	126	50.68	60.72	227
3) Diversified Health	693	580	56.47	58.69	241

Figure 12

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Health Occupations Education

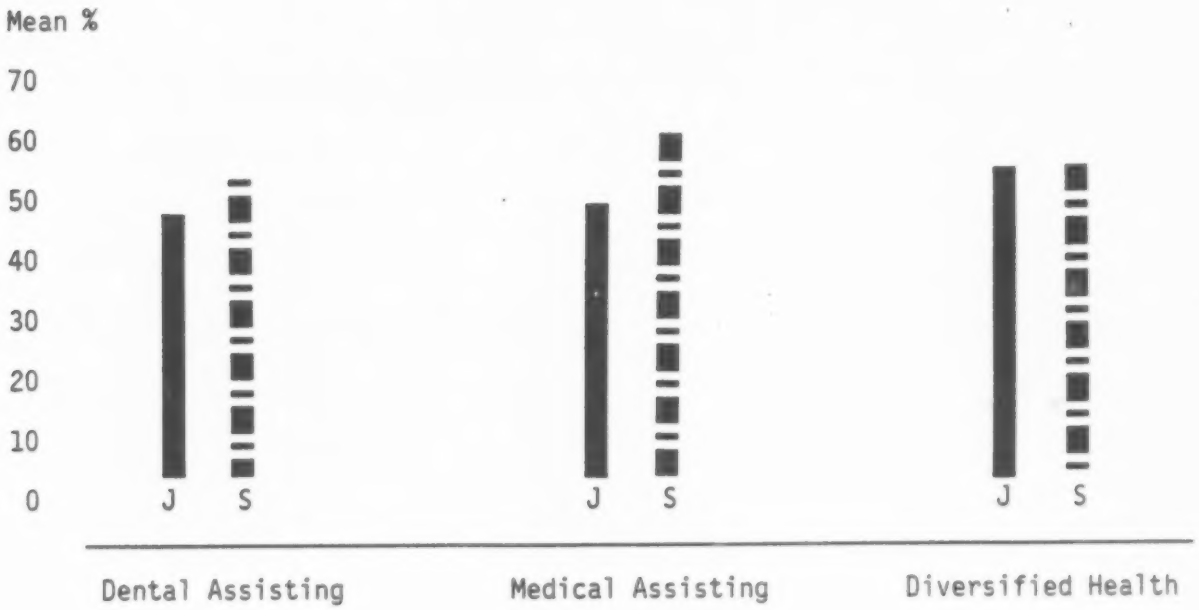


Table 11 shows the number of students who took the Vocational Education Achievement Tests in Health Occupation Education. The mean percentages indicate that the juniors scored 49% and seniors scored 56% in Dental Assisting, juniors scored 51% and seniors scored 59% in Diversified Health on the science questions answered correctly. As illustrated in Figure 12, seniors scored higher than juniors on the science questions in the Vocational Education Achievement Tests.

Table 12 shows the number of students who took the Vocational Education Achievement Tests in Home Economics Education and the mean performance of students who answered the science questions in the tests correctly. The juniors scored 32% and seniors scored 36% in Fabric Services, juniors scored 48% and seniors scored 48% in Home Economics Food Services, juniors scored 62% and seniors scored 63% in Community and Home Services, juniors scored 58% and seniors scored 63% in Child Care Services on correctly answered science questions. Small differences between the mean percentages of juniors and seniors in Home Economics Food Services and Community and Home Services were revealed in the bar graphs illustrated in Figure 13. The mean performance of seniors in Fabric Services and Child Care Services were also higher than their junior counterparts. In all cases the seniors outperformed their juniors on the science questions on the Vocational Education Achievement Tests. On all levels the Fabric Services Test, the performance of the students was approximately at the 50% level or above.

Table 13 shows the total number of students, both juniors and seniors, in 16 programs of Trade and Industrial Education who took the Vocational Education Achievement Tests, and the mean performance of juniors and seniors in correctly answering the science questions in the tests. Illustrated in Figures 14 through 16, the performance of seniors in the 16 programs were

higher than those of the juniors. In addition, the average performance of seniors ranged from 41% to 60%. The performance of the juniors ranged from 34% to 50%.

Table 12

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Home Economics Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Fabric Services	137	85	31.85	36.21	27
2) Home Economics Food Services	766	676	48.46	49.04	63
3) Community and Home Services	162	96	61.91	63.16	109
4) Child Care Services	624	484	57.53	62.83	151

Figure 13

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Home Economics Education

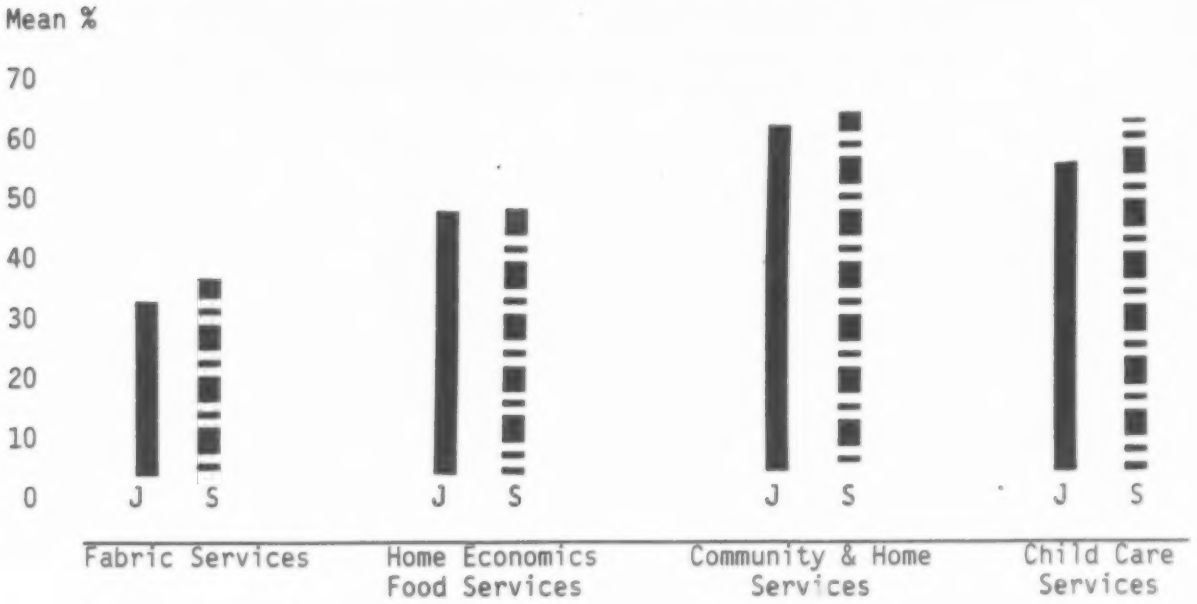


Table 13

Mean Percentages of Science Questions Correctly Answered by by Juniors and Seniors in Trade and Industrial Education

Occupational Program	Total Number		Mean Percentage		Total No. of Items
	Juniors	Seniors	Juniors	Seniors	
1) Auto Body Mechanics	1,083	1,061	41.69	48.33	77
2) Automotive Mechanics	1,717	1,648	37.49	46.68	109
3) Carpentry	767	907	49.15	59.58	40
4) Commercial Art	309	307	47.72	51.94	43
5) Communication Products Electronics	764	714	34.34	42.28	257
6) Construction Electricity	500	514	45.74	57.96	98
7) Cosmetology	1,593	1,614	49.65	59.42	221
8) Diesel Mechanics	331	390	43.08	52.00	60
9) Mechanical Drafting	578	827	34.60	40.73	62
10) Heat, Air Conditioning and Refrigeration	291	286	50.17	58.16	75
11) Industrial Electronics	478	446	36.72	46.97	257
12) Lithographic Printing	482	499	39.20	47.09	54
13) Machine Trade	901	1,191	36.02	42.55	24
14) Masonry	202	2-5	44.18	54.27	19
15) Small Engine Repair	181	150	46.93	56.56	79
16) Welding	938	1,075	42.78	50.27	68

Figure 14

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Trade and Industrial Education

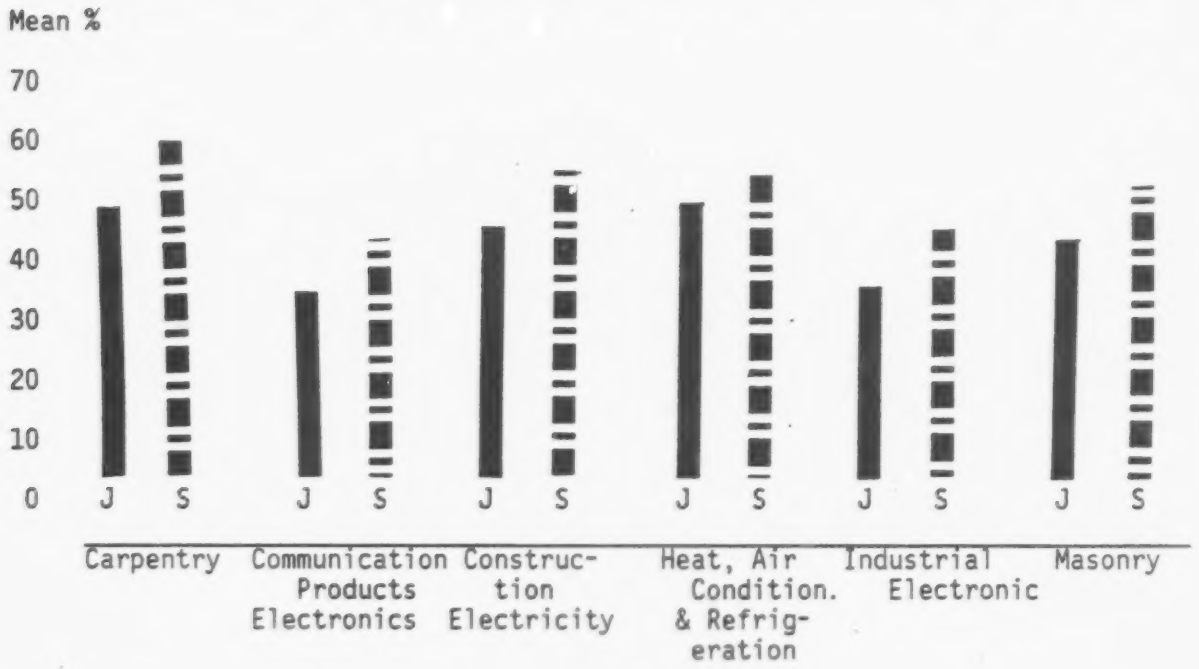


Figure 15

Mean Percentages of Science Questions Correctly Answered by Juniors ahd Seniors in Trade and Industrial Education

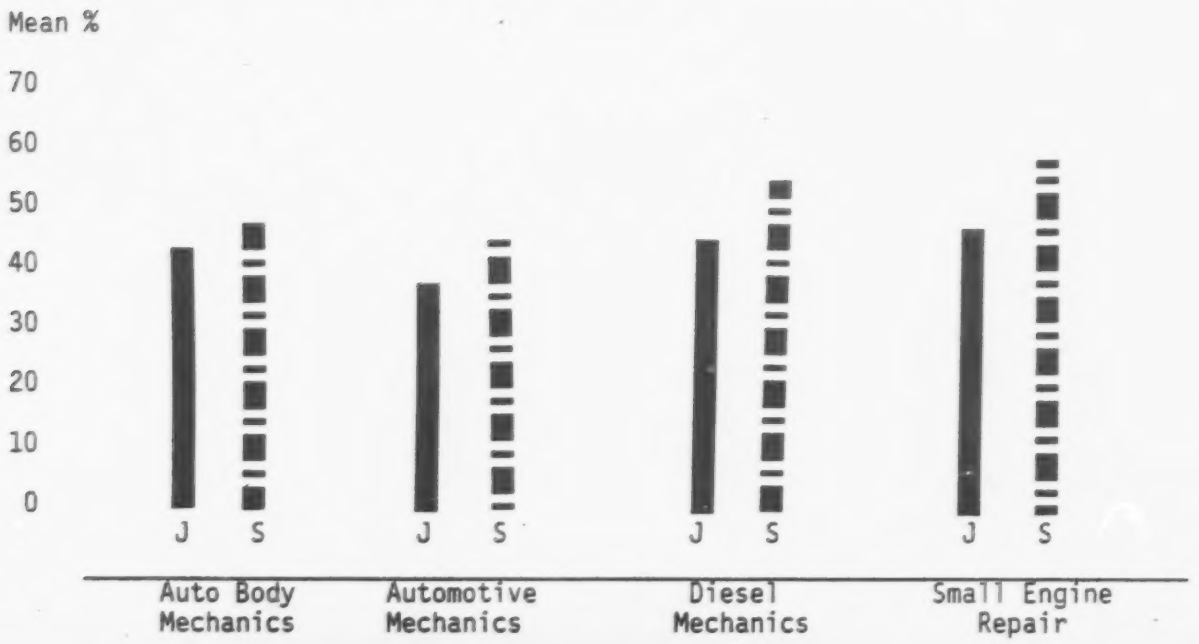
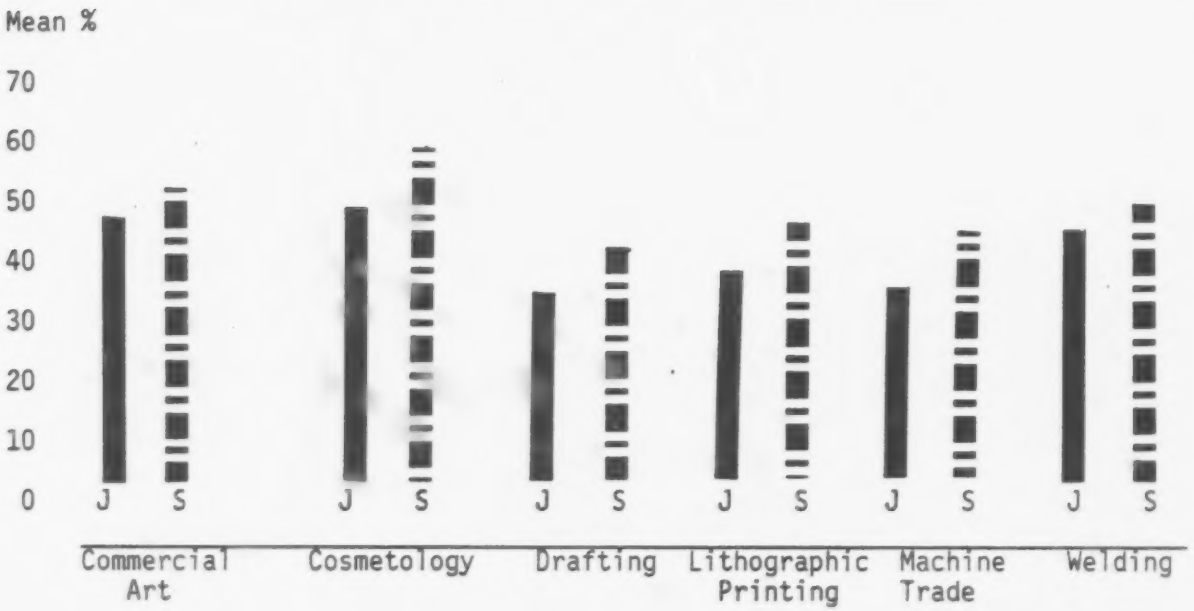


Figure 16

Mean Percentages of Science Questions Correctly Answered by Juniors and Seniors in Trade and Industrial Education



In general, the mean percentages of correctly answered mathematics and science questions in the Vocational Education Achievement Tests was higher for for seniors than for juniors in the same occupational program. In other words, seniors outperformed juniors on mathematics and science questions in almost every occupational program.

However, there were some programs where the mean percentages of seniors was lower than that of the juniors. For example, in answering mathematics questions, the mean performance of the juniors in D.E. Food Service Personnel was 45% whereas the seniors scored 38%. The mean performance of juniors in Food Marketing was 41% whereas the seniors scored 40%. Similarly, in answering science questions, the mean performance of juniors in Apparel and Accessories was 69% whereas the seniors scored 59%; the mean performance of juniors and seniors in Food Marketing was 44% and 43% respectively. Except

for Food Service Personnel and Apparel and Accessories Tests, this difference appears to be trivial. Reasons for these situations probably are due to small number of subjects and/or small numbers of items and reflect sampling error.

(2) THE VARIATION OF RAW SCORES ON MATHEMATICS AND SCIENCE PERFORMANCE

By examining the students' raw scores on mathematics and science items included in the Ohio Vocational Education Achievement Tests, the mean scores, medians and standard deviations in mathematics and science of juniors and seniors in 38 programs were obtained. Tables 14-36 illustrate the mean, median and standard deviation of vocational students by program areas. Also provided in these tables are total possible scores in mathematics and science, and maximum and minimum scores obtained by the students in each program.

In general, seniors performed equal to or better than juniors on the mathematics items in almost every program in Agricultral Education and Trade and Industrial Education, and performed slightly better in Business and Office Education and Health Occupations Education. However, mathematics performance of seniors were not different from that of juniors in Marketing and Home Economics Education.

In science, seniors performed better in Agricultural, Health Occupations and Trade and Industrial Education, and slighlty better in Business and Office Education. However, seniors' performance in science were not different from juniors' in Home Economics Education except for Child Care Services.

Table 14

Raw Score Performance in Mathematics of Juniors in Agricultural Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Agricultural Business	41	34	0	16.73	16.0	6.16
2) Agricultural Mechanics	20	18	0	8.16	8.0	3.18
3) Farm Management	80	52	6	24.95	23.5	8.30
4) Horticulture	14	12	0	5.17	5.0	2.18
5) Production Agriculture	20	19	1	7.87	7.0	4.23

Table 15

Raw Score Performance in Mathematics of Seniors in Agricultural Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Agricultural Business	41	39	0	17.26	16.0	6.7
2) Agricultural Mechanics	20	18	0	9.24	9.0	3.51
3) Farm Management	80	69	13	31.49	29.0	11.68
4) Horticulture	14	12	0	5.73	6.0	2.30
5) Production Agriculture	20	20	2	9.83	8.0	4.46

Table 16

Raw Score Performance in Mathematics of Juniors in Business and Office Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Accounting/Computing Clerk	47	39	0	18.01	18.0	6.57
2) Clerk Typist	23	22	0	8.48	8.0	4.12
3) Clerk Stenographer	24	23	0	10.79	11.0	4.20
4) Data Processing	33	19	0	9.71	10.0	3.49
5) General Office Clerk	26	26	0	11.17	11.0	4.76
6) Word Processing	15	15	0	7.77	8.0	2.81

Table 17

Raw Score Performance in Mathematics of Seniors in Business and Office Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Accounting/Computing Clerk	47	45	0	22.05	22	8.76
2) Clerk Typist	29	23	0	9.70	10	4.78
3) Clerk Stenographer	24	24	0	12.66	13	4.83
4) Data Processing	33	19	0	10.98	11	3.44
5) General Office Clerk	26	25	0	11.95	11	5.02
6) Word Processing	15	15	0	8.47	9	2.89

Table 18

Raw Score Performance in Mathematics of Juniors in Marketing Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Apparel Accessories	22	21	0	13.10	14	5.07
2) D.E. Food Service Personnel	18	18	0	8.04	8.0	4.47
3) Food Marketing	38	32	0	15.56	16.0	7.82
4) General Merchandising	37	33	0	15.00	14.0	6.50

Table 19

Raw Score Performance in Mathematics of Seniors in Marketing Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Apparel Accessories	22	20	3	13.59	15	3.94
2) D.E. Food Service Personnel	18	15	0	6.92	6	3.49
3) Food Marketing	38	31	4	15.34	15	7.25
4) General Merchandising	37	35	0	15.75	15	7.35

Table 20

Raw Score Performance in Mathematics of Juniors in Health Occupations Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Dental Assisting	5	5	0	1.95	2.0	1.14
2) Medical Assisting	22	19	0	9.43	10.0	4.39
3) Diversified Health	15	14	0	7.20	7.0	2.54

Table 21

Raw Score Performance in Mathematics of Seniors in Health Occupations Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Dental Assisting	5	5	0	2.47	3.0	1.13
2) Medical Assisting	22	20	0	11.73	12.0	4.07
3) Diversified Health	15	14	0	7.44	7.0	2.61

Table 22

Raw Score Performance in Mathematics of Juniors in Home Home Economics Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Fabric Services	22	17	0	7.56	8.0	3.72
2) Home Economics Food Services	20	19	0	9.44	9.0	3.83
3) Community & Home Services	4	4	0	2.67	3.0	10.01
4) Child Care Services	5	5	0	3.50	4.0	1.30

Table 23

Raw Score Performance in Mathematics of Seniors in Home Economics Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Fabric Services	22	17	0	9.73	10	3.55
2) Home Economics Food Services	20	19	0	9.80	10	4.19
3) Community & Home Services	4	4	0	2.77	3	1.08
4) Child Care Services	5	5	0	3.59	4	1.28

Table 24

Raw Score Performance in Mathematics of Juniors in Trade and Industrial Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Auto Body Mechanics	25	19	0	8.76	8.0	3.44
2) Automotive Mechanics	38	29	0	13.59	13.0	4.40
3) Carpentry	81	69	0	31.62	30.0	10.71
4) Commercial Art	41	36	0	19.37	19.0	6.02
5) Communication Product Electronics	76	55	0	26.03	26.0	7.37
6) Construction Electricity	55	48	0	23.25	22.0	7.74

Table 24 (continued)

Raw Score Performance in Mathematics of Juniors in Trade and Industrial Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
7) Cosmetology	9	9	0	4.35	4.0	1.72
8) Diesel Mechanics	16	14	0	6.89	7.0	2.73
9) Drafting	121	99	0	49.13	47.0	14.83
10) Heating/Air Conditioning & Refrigeration	6	6	0	2.36	2.0	1.53
11) Industrial Electronics	84	70	0	31.69	31.0	9.52
12) Lithographic Printing	43	34	0	14.62	14.0	5.67
13) Machine Trade	57	51	0	27.15	27.0	8.35
14) Masonry	23	20	0	8.01	8.0	4.09
15) Small Engine Repair	40	36	0	18.87	19.0	7.53
16) Welding	40	38	0	15.91	15.0	6.46

Table 25

Raw Score Performance in Mathematics of Seniors in Trade and Industrial Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Auto Body Mechanics	25	21	0	10.01	10.0	3.88
2) Automotive Mechanics	38	34	0	16.08	16.0	5.38
3) Carpentry	81	77	0	39.98	39.0	13.95
4) Commercial Art	41	39	0	20.53	21.0	6.82
5) Communication Product Electronics	76	69	0	30.10	29.0	10.24
6) Construction Electricity	55	52	0	29.10	29.0	8.50
7) Cosmetology	9	9	0	5.01	5.0	1.77
8) Diesel Mechanics	16	16	0	7.80	8.0	2.83
9) Drafting	121	99	0	54.16	54.0	16.33
10) Heating/Air Conditioning & Refrigeration	6	6	0	2.64	3.0	1.50
11) Industrial Electronics	84	78	0	40.73	41.0	13.85
12) Lithographic Printing	43	36	0	17.09	16.0	6.34
13) Machine Trade	57	54	0	32.11	33.0	8.79
14) Masonry	23	22	0	10.80	10.0	4.71
15) Small Engine Repair	40	39	0	21.53	22.0	8.61
16) Welding	40	37	0	19.85	20.0	7.36

Table 26

Raw Score Performance in Science of Juniors in Agricultural Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Agricultural Business	40	32	0	14.85	15.0	5.99
2) Agricultural Mechanics	74	65	0	30.09	29.0	10.45
3) Farm Management	37	26	3	13.56	13.0	5.09
4) Horticulture	92	67	0	35.31	35.0	11.21
5) Production Agriculture	85	66	8	35.60	34.0	12.47

Table 27

Raw Score Performance in Science of Seniors in Agricultural Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Agricultural Business	40	40	0	17.78	18.0	7.27
2) Agricultural Mechanics	74	67	0	35.11	35.0	12.69
3) Farm Management	37	33	3	17.59	17.0	6.0
4) Horticulture	92	74	0	40.24	40.0	12.47
5) Production Agriculture	85	83	14	41.58	40.5	12.48

Table 28

Raw Score Performance in Science of Juniors in Business and Office Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Accounting/Computing Clerk	5	5	0	2.58	3.0	1.40
2) Clerk Typist	4	4	0	1.68	2.0	1.31
3) Clerk Stenographer	10	10	0	5.09	5.0	1.77
4) Data Processing	264	144	0	86.94	85.0	21.28
5) General Office Clerk	7	7	0	3.22	3.0	1.53
6) Word Processing	42	40	0	23.62	24.0	7.24

Table 29

Raw Score Performance in Science of Seniors in Business and Office Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Accounting/Computing Clerk	5	5	0	2.9	3.0	1.43
2) Clerk Typist	4	4	0	1.81	2.0	1.35
3) Clerk Stenographer	10	9	0	5.61	6.0	1.79
4) Data Processing	264	145	0	101.42	104.0	23.82
5) General Office Clerk	7	7	0	3.42	4.0	1.53
6) Word Processing	42	41	2	27.53	2.9	7.47

Table 30

Raw Score Performance in Science of Juniors in Marketing Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Apparel Accessories	2	2	0	1.39	1.5	0.69
2) D.E. Food Service Personnel	31	30	0	14.24	14.0	8.40
3) Food Marketing	15	14	1	6.67	7.0	2.78
4) General Merchandising	13	13	0	7.04	7.0	2.96

Table 31

Raw Score Performance in Science in Seniors in Marketing Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Apparel Accessories	2	2	0	1.17	1.0	0.76
2) D.E. Food Service Personnel	31	27	0	14.81	14.0	7.81
3) Food Marketing	15	13	0	6.41	6.0	3.16
4) General Merchandising	13	13	0	7.30	8.0	3.11

Table 32

Raw Score Performance in Science of Juniors in Health Occupations Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Dental Assisting	192	166	0	94.62	93.5	24.37
2) Medical Assisting	252	185	0	114.80	116.0	35.98
3) Diversified Health	241	199	0	136.09	137.0	28.75

Table 33

Raw Score Performance in Science of Seniors in Health Occupations Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Dental Assisting	192	168	42	113.45	116.0	24.27
2) Medical Assisting	252	207.	38	137.21	139.0	34.0
3) Diversified Health	241	213	0	141.30	144.0	30.63

Table 34

Raw Score Performance in Science of Juniors in Home Economics Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Fabric Services	27	19	0	8.60	9.0	3.91
2) Home Economics Food Services	63	59	0	30.66	31.0	10.58
3) Community & Home Servies	109	98	10	67.54	68.0	17.50
4) Child Care Services	151	129	0	82.28	88.0	25.36

Table 35

Raw Score Performance in Science of Seniors in Home Economics Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Fabric Services	27	22	0	9.64	10.0	4.0
2) Home Economics Food Services	63	60	0	30.86	31.0	11.31
3) Community & Home Services	109	97	9	68.43	71.0	17.68
4) Child Care Services	151	140	0	90.38	97.0	26.76

Table 36

Raw Score Performance in Science of Juniors in Trade and Industrial Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Auto Body Mechanics	77	60	0	32.10	31.0	9.76
2) Automotive Mechanics	109	90	0	39.79	38.0	13.16
3) Carpentry	40	34	0	19.66	20.0	6.22
4) Commercial Art	43	37	0	20.64	21.0	6.53
5) Communication Product Electronics	257	188	0	88.26	85.0	25.72
6) Construction Electricity	98	83	0	44.81	44.0	13.22
7) Cosmetology	221	191	0	109.65	111.0	28.16
8) Diesel Mechanics	60	48	0	25.85	25.0	7.83
9) Drafting	62	53	0	20.87	20.0	6.94
10) Heating/Air Conditoning & Refrigeration	75	60	0	37.08	37.0	10.70
11) Industrial Electronics	257	229	0	94.26	90.0	28.01
12) Lithographic Printing	54	44	0	21.17	21.0	7.87
13) Machine Trade	24	19	0	8.63	8.0	3.47
14) Masonry	19	15	0	8.39	9.0	3.65
15) Small Engine Repair	79	68	0	36.53	37.0	12.53
16) Welding	68	61	0	29.04	29.0	9.31

Table 37

Raw Score Performance in Science of Seniors in Trade and Industrial Education

Occupational Areas	Total Possible Score	Max	Min	Mean	Med	SD
1) Auto Body Mechanics	77	72	0	37.12	37.0	11.65
2) Automotive Mechanics	109	98	0	49.56	49.0	16.73
3) Carpentry	40	40	0	23.75	24.0	7.26
4) Commercial Art	43	38	0	22.29	23.0	6.90
5) Communication Product Electronics	257	225	0	108.59	107.0	37.08
6) Construction Electricity	98	89	0	57.08	57.0	14.46
7) Cosmetology	221	209	0	131.50	133.0	31.32
8) Diesel Mechanics	60	58	0	31.21	315.0	9.77
9) Drafting	62	46	0	24.39	24.0	7.73
10) Heating/Air Conditioning & Refrigeration	75	67	14	42.80	44.0	10.96
11) Industrial Electronics	257	242	0	120.61	119.5	42.05
12) Lithographic Printing	54	46	0	25.36	25.0	9.12
13) Machine Trade	24	20	0	10.19	10.0	3.78
14) Masonry	19	16	0	10.31	11.0	3.89
15) Small Engine Repair	79	73	0	43.51	45.0	15.54
16) Welding	68	61	0	34.07	35.0	9.83

(3) VARIATION OF PERFORMANCE ACROSS VOCATIONAL AREAS ON THE SHORT FORM TEST OF ACADEMIC APTITUDE

Using only the total test score of the SFTAA (level 5), an indication of relative academic ability across the 38 vocational areas for juniors and seniors can be found in Table 38. As expected, the seniors as a group perform better than the juniors. The median score for the seniors across all program areas is approximately 50. The means for the juniors range from a low of approximately 41 to a high of approximately 55. The corresponding range for the seniors runs from 44 to 60. The standard deviation of scores within each program are ranges between 10 and 13 points.

TABLE 38

1985 Performance on the Short Form Test of Academic Aptitude for Juniors/Seniors participating in Ohio Vocational Education Program

	JUNIORS		SENIORS	
	Mean	S.D.	Mean	S.D.
OCCUPATIONAL TESTS				
Agricultural Education				
Agricultural Business	45.94	12.26	49.20	10.98
Agricultural Mechanics	43.90	12.21	47.62	12.36
Farm Management	43.98	11.41	46.27	12.53
Horticulture	44.15	12.96	46.57	12.53
Production Agriculture	45.13	12.96	51.07	12.32
BUSINESS AND OFFICE EDUCATION				
Accounting/Computing Clerk	52.20	10.13	55.66	9.85
Clerk-Stenographer	51.95	9.90	55.42	9.95
Clerk Typist	46.69	10.61	50.38	10.59
Data Processing	54.33	10.03	58.28	10.19
General Office Clerk	49.32	10.57	50.03	10.64
Word Processing	50.24	9.86	53.38	10.64
DISTRIBUTIVE EDUCATION				
Apparel & Accessories	51.02	11.70	53.21	9.87
D.E. Food Service Personnel	49.58	11.29	-	-
Food Marketing	47.42	11.78	49.51	13.35
General Merchandising	48.67	12.14	49.85	11.98
HEALTH OCCUPATIONS EDUCATION				
Dental Assisting	48.20	10.64	54.07	9.82
Medical Assisting	49.86	10.82	53.31	10.54
Diversified Hlth Occupations	49.35	10.88	52.17	11.10
HOME ECONOMICS EDUCATION				
Community & Home Services	42.76	12.87	44.77	13.58
Fabric Services	40.76	12.86	43.43	11.31
Home Economics Food Services	41.25	12.81	43.74	13.86
Child Care Services	42.50	11.48	44.17	11.77
TRADE AND INDUSTRIAL EDUCATION				
Auto Body	42.96	11.29	48.53	11.54
Automotive Mechanics	45.81	11.40	50.00	11.99
Building Maintenance	45.12	13.03	45.60	12.19
Carpentry	45.74	11.82	49.78	11.25
Commercial Art	49.62	12.51	56.51	11.52
Construction Electricity	49.59	11.38	54.38	11.16
Cosmetology	48.34	10.06	51.18	11.01
Diesel Mechanic	46.00	10.88	49.97	10.86
Drafting	54.26	10.94	57.33	11.18
Electronics-Comm. Prod.	53.51	10.42	58.08	10.11
Electronics-Industrial	54.68	10.81	59.50	9.33
Heating/Air Cond./Refrig.	46.55	10.86	51.40	11.15
Lithographic Printing	47.71	11.77	51.82	11.97
Machine Trades	48.66	10.99	53.00	11.18
Masonry	41.24	12.68	44.27	12.39
Small Engine Repair	42.29	12.50	46.41	12.10
Welding	45.39	11.28	48.89	11.70

Part III Comparison of Students Enrolled in Vocational and Traditional Education on Common Indicators of Performance

Part III Comparison of Students Enrolled In Vocational and Traditional Education on Common Indicators of Performance

The purpose of the study was to determine the feasibility of comparing the performance in mathematics, science and academic aptitude of students enrolled in three different programs; vocational, college-preparatory and general education. It was expected that the feasibility study would provide substantial information for making decisions, whether more advanced study in comparison of student performance in mathematics and science should be conducted or not. And, if the more advanced study is feasible then to point out areas for investigation, potential pitfalls and minor areas of difficulty.

In comparing the mathematics and science performance of students in different types of curriculum, three common indicators were examined. These three indicators were classified as:

1. Student performance on correctly answered questions:
   - 1.1 The mean percentage of correctly answered mathematics questions
   - 1.2 The mean percentage of correctly answered science questions
2. Student performance on correctly answered questions:
   - 2.1 The mean raw score of correctly answered mathematics questions
   - 2.2 The mean raw score of correctly answered science questions
3. Student performance on the short form test of academic aptitude

Sources of Data

1) Performance of Vocational Students in Science, Mathematics and Academic Aptitude

From hard data which already exists at the Ohio Vocational Education Testing Office (OVET) located at The Ohio State University, performances of vocational students in three different program areas were chosen for study. These program areas were Welding, Home Economics Food Services and

Carpentry. In choosing these programs, consideration was given to the proportion of mathematics and science items included in each test, and the number of vocational students who took the Ohio Vocational Achievement Tests in 1985. The performance of students who took the Welding, Home Economics Food Services and Carpentry Achievement Tests were analyzed to obtain the common indicators for the comparative study. The mean percentages of correctly answered questions on the mathematics and science items were calculated for all seniors taking the respective tests. Arithmetic means and standard deviation of raw scores in mathematics, science and the SFTAA for each test were also tabulated.

2) Performance of Students in Traditional Education in Mathematics, Science and Academic Aptitude.

Senior students attending traditional high school programs were administered the science and mathematics items found in the Carpentry, Welding and Home Economics Food Services forms of the OVET. A description of the instrument, test content and sample sizes are provided below:

2.1 Instruments: Mathematics and Science Achievement Tests

To obtain performances in mathematics and science of the students in traditional educational institutions, modified forms of tests were developed. The modification was accomplished by extracting the science and math items from the respective total test forms and putting the math items together in Part I and the science together in Part II. Among the 38 Ohio Vocational Achievement Tests administered in 1985, three occupational tests were chosen to measure mathematics and science performance of students. Those chosen occupational tests were Welding, Home Economics Food Services and Carpentry. The modified forms of these tests are called the

Mathematics and Science Achievement Test Form I, Form II, and Form III respectively. Each of these tests is divided into two parts. Part I includes all mathematics questions and Part II includes all science questions taken directly from the occupational tests. The determination of whether an item tapped mathematics, science, or both was done by a group of content area experts as part of the annual review of test content done by the OVET office.

Academic Aptitude

The SFTAA as previously described in this report was used as the indicator of academic aptitude.

2.11 Description of Tests by Content Areas

For this study, the science and mathematics items were further classified by content area and domains, (e.g., basic mathematics, algebra, physics, chemistry) and level according to Bloom's et. al, taxonomy (e.g., knowledge, application).

Table 39 reveals the number of mathematics questions included in the new forms of the Ohio Vocational Achievement Tests by subject areas in mathematics. Most of these questions are concentrated in geometry and basic mathematics respectively, especially in Form I and Form III. Out of 40 questions in Form I (Welding) there are 25 items (63%) in geometry, 14 items (35%) in basic mathematics, and only one question (2%) in algebra. Similarly, out of 81 questions in Form III (Carpentry), there are 63 items (78%) in geometry and 18 items (22%) in basic mathematics. However, questions in Form II (Home Economics Food Services) are in basic mathematics (19 out of 20 items or 95%) rather than geometry (where there is only one question).

Table 39

Description of Tests by Content Areas in Mathematics

Content Area	Form I Welding	Form II Home Economics Food Services	From III Carpentry
Basic Mathematics	14 (35%)	19 (95%)	18 (22%)
Algebra	1 (2%)	-	-
Geometry	25 (63%)	1 (5%)	63 (78%)
Total	40 (100%)	20 (100%)	81 (100%)

All science questions in the modified tests are included in Part II. The number of science questions by subject area is illustrated in Table 40. In Form I, there are 68 questions included in the test. There are 39 questions (57%) in chemistry and 29 questions (43%) in physics. In Form II, there are 63 items. The emphasis of these questions is on microbiology (21 items or 33%), chemistry (14 items or 22%), psychology (11 items or 18%), physiology (8 items or 13%) and physics (7 items or 11%) respectively. Only two (3%) questions are included in botany. In Form III, most of the questions are concentrated in physics (36 out of 40 questions or 90%). There are only 3 questions in chemistry and 1 question in botany.

Table 40

Description of Tests by Content Areas in Science

Content Areas	Form I Welding	Form II Home Economics Food Services	Form III Carpentry
Physics	29 (43%)	7 (11%)	36 (90%)
Chemistry	39 (57%)	14 (22%)	3 (8%)
Botany	--	2 (3%)	1 (2%)
Zoology	--	--	--
Microbiology	--	21 (33%)	--
Anatomy	--	--	--
Physiology	--	8 (13%)	--
Psychology	--	11 (18%)	--
Geology	--	--	--
Total	68 (100%)	63 (100%)	40 (100%)

(2) Description of Tests by Taxonomic Levels

All mathematics and science questions in the three forms of the Mathematics and Science Achievement Tests were also classified by taxonomic levels of performance. This classification is illustrated in Table 41.

In the mathematics part of each form, the major level of assessment is application. In Form I, thirty-two out of forty questions (80%) in mathematics measure ability of students in application. In this level, mathematical principles have to be applied to specific situations in answering the questions. Six questions (15%) in this part measure the level of knowledge which basically is the knowledge of mathematical criteria. In addition, there are two questions (5%) which measure the level of mathematical comprehension. In Form II, 18 out of 20 questions (90%) assess the ability of students in application, and the other two questions (10%) assess the students' knowledge of mathematical criteria and techniques used in the area of Home Economics Food Services. In Form III there are 51 out of 81 questions (63%) which measure the ability of students in the application

of mathematical principles. Twenty-five questions (31%) measure knowledge of classification and categorization, terminology, criteria, and methods and techniques employed in the area of carpentry. In addition, five questions (6%) assess students' ability in mathematical comprehension. Application is generally regarded as a reasonably refined level of understanding whereas knowledge is generally regarded as a low level of "understanding which usually requires the student to recall or recognize information." The mathematics items, in general, provide a good indication of a students' understanding of the mathematics concepts and content covered by the exam.

Table 41

Description of Tests by Taxonomic Levels

Taxonomic Levels	Welding Form I				Home Ec. Food Svc. Form II				Carpentry Form III			
	Math		Science		Math		Science		Math		Science	
Knowledge	6	(15)	65	(96)	2	(10)	61	(96)	25	(31)	32	(80)
Comprehension	2	(5)	--		-		--		5	(6)	--	
Application	32	(80)	1	(1)	18	(90)	1	(2)	51	(63)	1	(2)
Analysis	--		-		--		-		--		-	
Synthesis	--		-		--		-		--		-	
Evaluation	--		2	(3)			1	(2)	--		7	(18)
Total	40	(100)	68	(100)	20		63	(100)	81		40	(100)

Numbers in parentheses are percents

In part II of each test, which includes all the science questions, the major level of assessment is knowledge. There are 65 out of 68 questions (96%) in Form I, 61 out of 63 questions (96%) in Form II, and 32 out of 40 questions (80%) in Form III included in these tests which assesses the knowledge of terminology, specific facts, criteria, classification and categorization, and methods and techniques employed in particular areas,

and principles and generalizations used in explaining and describing phenomena. Only one question in each form is for assessing ability in application. In addition, there are 2, 1, and 7 questions in Form I, II and III respectively which assess ability in evaluation. The questions in the science area do not provide a good indication of the general understanding of science concepts and content. Rather, they represent rather specific knowledge and terminology likely to be possessed only by students who have been exposed to this content.

2.2 Sample:

With the cooperation of three local High Schools, three forms of Mathematics and Science Achievement Tests, modified from Welding, Home Economics Food Services, and Carpentry, and the SFTAA were administered in 1985 to obtain performance in mathematics, science and general academic ability of students in traditional high school programs. The sample of students in traditional programs consisted of 107 senior level students enrolled in college-preparatory programs and 99 senior level students enrolled in general programs. Each group of students from each school was divided into three subgroups where each form of the mathematics and science tests were administered. The total number of students who took the Mathematics and Science Achievement Tests is illustrated in Table 42 by form of test, by type of education, by school and by gender of the students. All students completed the SFTAA. The high schools were selected to purposely reflect a range of urban and rural locations as well as a representative range of cultural and socio-economic backgrounds.

Table 42

Number of Students in Traditional Education Programs Who Took the Mathematics and Science Achievement Tests

Test Forms	College-Prep							General						
	S_1		S_2		S_3		Total	S_1		S_2		S_3		Total
	M	F	M	F	M	F		M	F	M	F	M	F	
Form I (Welding)	9	4	6	4	4	7	34	3	3	4	6	10	5	31
Form II (Home Economics Food Services)	4	9	5	5	5	8	36	6	8	6	2	7	6	35
From III (Carpentry)	6	5	5	5	5	11	37	7	9	4	4	7	2	33
Total	19	18	16	14	14	26	107	16	20	14	12	24	13	99
													Grand Total	206

Data Analysis and Results

1) Performance of Students in Mathematics

1.1 The Mean performance of students who answered mathematics questions correctly is illustrated in Table 43 and figure 17. An examination of Table 43 and figure 17 reveals that the college-preparatory students have a higher percentage of correctly answered mathematics questions in Form I and Form II than either the vocational or general education students. The vocational students outperform the general education students on all three forms of the exam and outperform the college prep students on Form III. The general education students performed less well than the other groups on the mathematics questions on all forms of the test. The performance of the vocational education students is at about the 50% mark across all forms, but the performance level of the other two groups vary by form.

1.2 The average raw score and standard deviation of students' performance in mathematics is illustrated in Table 44 and Figure 18. Inspection of the data reveals the highest average scores of

college-preparatory students in Form I and Form II, while the highest average score on Form III was achieved by vocational students. These results must be interpreted in light of the total number of possible items on the respective forms and comparisons of raw scores across exam forms is not meaningful. There appears to be substantial differences between the general education students and the other two groups across all three test forms. Differences between the college prep and the vocational groups appear to be slightly in favor of the college prep group on forms I and II and substantially in favor of the vocational group on Form III.

Table 43

Mean Percentages of Correctly Answered Mathematics Questions by Seniors

Test Form	Vocational		College Prep		General	
	Total n	Mean %	Total n	Mean %	Total n	Mean %
Form I (Welding)	820	49.79	34	59.05	31	46.44
Form II (H. Ec. F. Serv.)	615	49.30	36	65.83	35	41.71
Form III (Carpentry)	731	49.34	37	26.47	33	18.56

Figure 17

Mean Percentage of Correctly Answered Mathematics Questions by Seniors

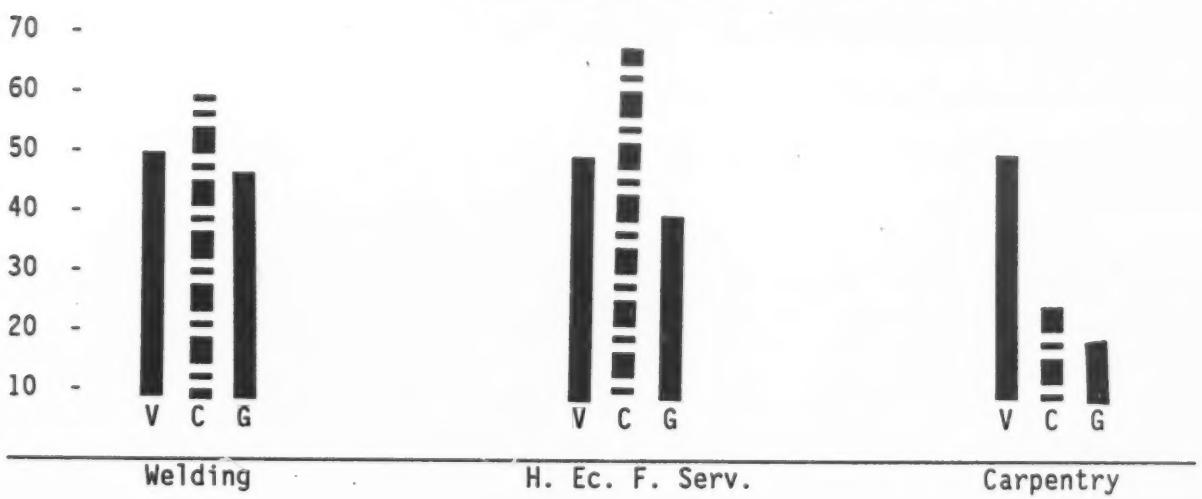


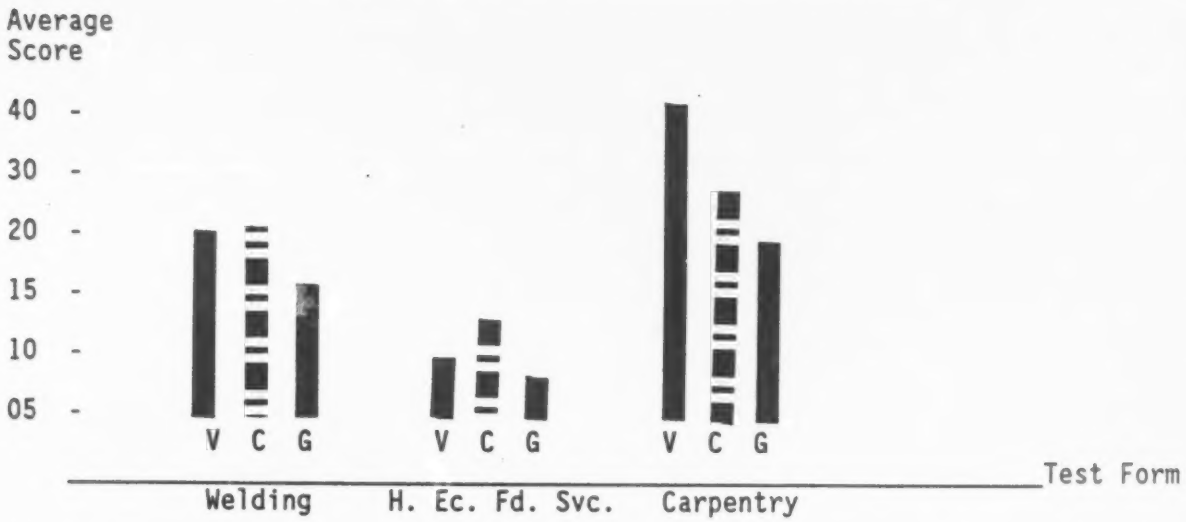
Table 44

Average Raw Scores and Standard Deviations of Mathematics Performance

Curriculum	Welding		H. Ec. Fd. Svc.		Carpentry	
	Mean	SD	Mean	SD	Mean	SD
Vocational	19.52	7.17	9.98	4.24	39.40	13.32
College-Preparatory	21.44	4.92	13.17	3.47	23.62	6.62
General	15.03	5.49	8.34	4.34	18.58	7.81

Figure 18

Average Raw Scores of Mathematics Performance



2) Performance of Students in Science

2.1 The mean percentage of correctly answered science questions is illustrated in Table 45 and Figure 19. An examination of Table 45 and Figure 19 reveals that Vocational students outperformed college prep and general education students on the science questions in Form I and Form III. The college-preparatory students outperformed the other two groups on the science questions in Form II. The general education students scored lowest on each form of the exam.

2.2 The average raw score and standard deviation of students' performance in science is illustrated in Table 46 and figure 20. It appears that there are substantial differences in raw score performance among all three groups on each test. Vocational students outperformed the college prep students who in turn outperformed the general education students in Form I and Form III. The college-preparatory students outperformed the vocational students who in turn outperformed the general education students in Form II. Students enrolled in general education performed at the lowest level in science on each test.

Table 45

Mean Percentages of Correctly Answered Science Questions by Seniors

Test Form	Vocational		College-Prep		General	
	Total n	Mean %	Total n	Mean %	Total n	Mean %
Form I (Welding)	820	50.27	34	28.85	31	22.34
Form II (Home Ec. Fd. Svs)	615	49.04	36	66.14	35	42.86
Form III (Carpentry)	731	59.58	37	37.63	33	25.61

Figure 19

Mean Percentages of Correctly Answered Science Questions by Seniors

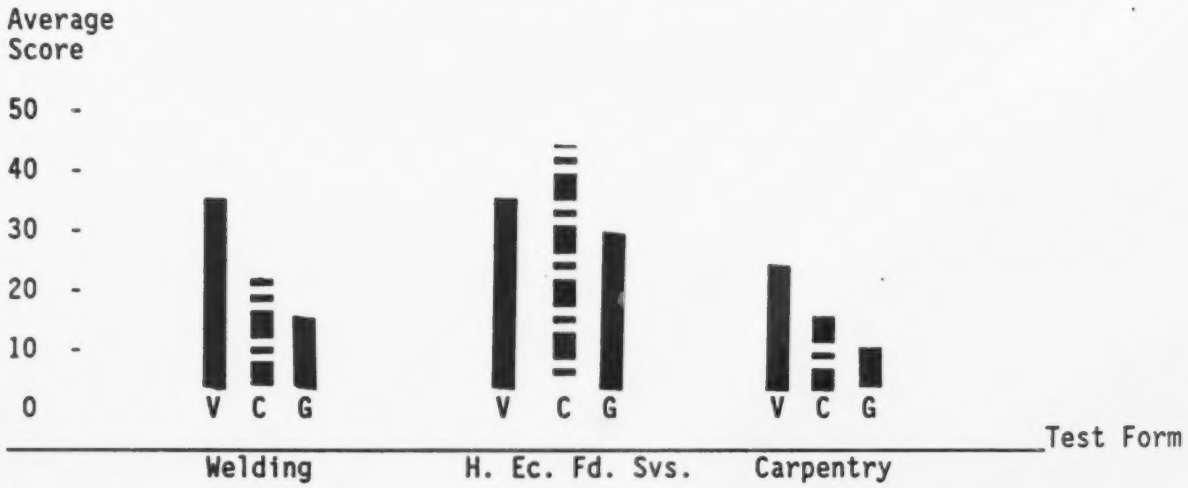
Table 46

Average Raw Scores and Standard Deviations of Science Performance

Curriculum	Welding		H.Ec. Fd. Svc.		Carpentry	
	Mean	SD	Mean	SD	Mean	SD
Vocational	33.84	9.8	31.86	11.53	23.66	7.15
College-Preparatory	19.62	6.33	41.67	9.53	15.05	6.81
General	15.87	6.58	27.00	13.77	10.24	5.81

Figure 20

Average Raw Scores of Science Performance



3. Performance of Students on SFTAA

3.1 All students participating in this study were administered the SFTAA. Table 47 presents information on the raw score performance. The SFTAA has a total of 85 items. Using the SFTAA as an indicator of academic ability, the college prep students consistently demonstrate higher levels of academic ability than either the vocational or the general students. The table also reveals a pattern of very similar performance between the vocational group and the general group; the general group scores about five to eight points above the vocational group in each subgroup. It is worth noting that these performances are consistent with performance as reflected across all vocational areas (see Table 38). Using Table 38, the relative performance of the senior students from the three selected vocations (Carpentry, Home Economics Food Service, and Welding) can be observed. As a group, the Home Economics Food Service Vocational students rank 36 out of 37. Students representing the Carpentry and Welding areas are also below the median value for all areas of vocational education; they rank 23 and 27 out of 37 respectively. Thus, the selection of Carpentry and Welding as

Table 47

Raw Score Means and Standard Deviations of Test Scores on Math, Science, and SFTAA by Testform and Academic Group

Testform (n) Group	MATH	SCIENCE	SFTAA TOTAL
CARPENTRY			
College (n=37)			
M	23.62	15.05	62.95
SD	6.62	6.81	9.80
General (n=33)			
M	18.58	10.24	51.36
SD	7.81	5.81	9.80
Vocational (n=731)			
M	39.39	23.66	47.95
SD	13.32	7.15	14.55
HOME EC.			
College (n=36)			
M	13.17	41.67	65.75
SD	3.47	9.53	6.96
General (n=35)			
M	8.34	27.00	49.83
SD	4.34	13.77	12.77
Vocational (n=615)			
M	9.99	31.86	41.97
SD	4.24	11.53	15.87
WELDING			
College (n=34)			
M	21.44	19.62	65.79
SD	4.92	6.33	8.01
General (n=31)			
M	15.03	15.87	52.32
SD	5.49	6.58	10.51
Vocational (n=820)			
M	19.52	33.84	47.12
SD	7.17	9.81	14.59
OVERALL (n=2372)			
M			44.01
SD			15.31

areas of investigation for this study represents students from the "low average" range of academic ability of all vocational education students. Further, the Home Economics Food Services group represents one of the most limited groups with respect to academic ability.

Statistical Comparisons of Performance

More rigorous statistical tests were applied to the data to aid in interpretation. Using the raw scores on the SFTAA, the science test and the math test as dependent variables, a series of one-way analyses of variance tests were conducted. Using the three levels of academic program as the independent variable, performance on each form of the exam (I, II and III) for science and then math were contrasted. An overall contrast among the three groups was also conducted using the SFTAA. Significant differences were found for all of the analyses using the mathematics and science scores (six analyses). Significant differences were also found for the Welding, Home Economics Food Services, Carpentry and Total Combined groups with respect to the SFTAA score. These analyses were then followed by a Scheffe' Test to determine statistically significant differences among various pairs of means. Figure 21 graphically portrays the respective differences. In general, the college prep group had better academic ability than the other two groups; there was only one significant difference (Home Economics Food Services) in academic ability between the general group and the vocational group although the students in the vocational group were slightly lower than the students in the general group on all three test forms according to the SFTAA.

With respect to the contrasts among the three academic program areas with respect to the science and math scores, the vocational group was significantly higher than the general group on four of the six tests and

Figure 21

Significant and Non Significant Differences on the Mathematics, Science and SFTAA Scores Among Academic Groups.

Mathematics

Welding	C	NS	V *	*	G
Home Economics Food Services	C	*	V *	NS	G
Carpentry	V	*	C *	NS	G

Science

Welding	V	*	C *	NS	G
Home Economics Food Services	C	*	V *	NS	G
Carpentry	V	*	C *	*	G

SFTAA

Welding	C	*	G *	NS	V
Home Economics Food Services	C	*	G *	*	V
Carpentry	C	*	G *	NS	V
Total	C	*	G *	NS	V

C = College Prep
V = Vocational
G = General

* = Significant difference @ $p \leq .05$
NS = Non Significant difference

Means listed in descending order from left to right

scored higher than the general group on the remaining two tests but this difference was not statistically significant. Again using the science and math scores, in four cases the college prep group was significantly higher than the general group and in two cases the difference between these two groups was not statistically significant; the college prep group scored higher than the general group in all six cases. When contrasting the vocational group with the college prep group on the science and math scores, the vocational group was significantly higher than the college prep group in three of the six cases; the college prep group was significantly higher than the vocational group on two tests and there was no significant differences between the two groups on the remaining test although the college prep group score was slightly above that of the vocational group.

Table 48

Analysis of Covariance of Academic Group and Math SCORE Employing SFTAA as a Covariate of Testform I (Welding)

Source	df	MS	F
Academic Group Adjusted by SFTAA	2	493.60	11.94*
Error	881	41.34	

* $p \leq .001$

Table 49

Analysis of Covariance of Academic Group and Math SCORE
Employing SFTAA as a Covariate of Testform II
(Home Economics Food Services)

Source	df	MS	F
Academic Group Adjusted by SFTAA	2	129.56	10.39*
Error	682	12.47	

* $p \leq .001$

Table 50

Analysis of Covariance of Academic Group and Math SCORE
Employing SFTAA as a Covariate of Testform III (Carpentry)

Source	df	MS	F
Academic Group Adjusted by SFTAA	2	15,203.97	116.65*
Error	797	130.33	

* $p \leq .001$

Table 51

Analysis of Covariance of Academic Group and Science SCORE
Employing SFTAA as a Covariate of Testform I (Welding)

Source	df	MS	F
Academic Group Adjusted by SFTAA	2	11,235.25	153.94*
Error	881	72.99	

* $p \leq .001$

Table 52

Analysis of Covariance of Academic Group and Science SCORE
Employing SFTAA as a Covariate of Testform II
(Home Economics Food Service)

Source	df	MS	F
Academic Group Adjusted by SFTAA	2	1143.59	13.20*
Error	682	72.99	

* $p \leq .001$

Table 53

Analysis of Covariance of Academic Group and Science SCORE
Employing SFTAA as a Covariate of Testform III (Carpentry)

Source	df	MS	F
Academic Group Adjusted by SFTAA	2	5,205.89	126.35*
Error	797	41.18	

* $p \leq .001$

Table 54

Adjusted Means of Academic Groups by Testform
Employing SFTAA as the Covariate

Testform Academic Groups	n	Math	Science
Carpentry			
College	37	17.61	12.05
General	33	17.48	9.70
Vocational	731	39.75	23.84
Home Economics			
College	36	9.88	31.80
General	35	7.42	24.23
Vocational	615	10.23	32.60
Welding			
College	34	17.85	14.13
General	31	14.16	14.54
Vocational	820	19.70	34.12

The analysis of covariance (ANCOVA) technique statistically equates the groups based on existing differences among groups on the covariate (see Table 54). The mean scores for the respective vocational groups showed minimal adjustments. The values for the college prep group were adjusted downward and the values for the general group was adjusted slightly upward. This is consistent with initial differences among the groups on academic ability.

Based on the statistically significant ANCOVA results (see Tables 48-53) and the subsequent adjustments in group means, a Scheffe' procedure was used to make pair-wise contrasts among the groups. This procedure was used to determine which, if any, of the three academic groups differed statistically from the other two groups. Tables 55-60 identify significant differences among groups for each test form based on the science and math variables.

Each of the cells in the six tables contains the difference between the pairwise means ($\bar{X}$ dif) and the corresponding F ratio.

When adjusted for ability, the vocational groups perform statistically significantly better than the general groups on all the science and math tests across the three test forms. This is consistent with the analysis of the unadjusted scores.

Table 55

Contrasts of Academic Groups Based on Scheffe' Procedure
Using Adjusted Math Score Means for Test Form I (Welding)

	General	Vocational
College Prep	F = 5.28* X dif = 3.69	F= 2.56 (NS) X dif = -1.85
General		F= 22.13** X dif = -5.54

** Significant at $p \leq .01$ NS = Not significant
* Significant at $p \leq .05$

Table 56

Contrasts of Academic Groups Based on Scheffe' Procedure
Using Adjusted Math Score Means for Test Form II
(Home Economics Food Service)

	General	Vocational
College Prep	F = 8.39 ** X dif = 2.46	F= .30 (NS) X dif = -.35
General		F= 20.71** X dif = -2.81

** Significant at $p \leq .01$ NS = Not significant

Table 57

Contrasts of Academic Groups Based on Scheffe' Procedure
Using Adjusted Math Score Means for Test Form III
(Carpentry)

	General	Vocational
College Prep	F = .00 (NS) X dif = .13	F= 126.81** X dif = -22.14
General		F= 120.04** X dif = 22.27

** Significant at p .01 NS = Not significant

Table 58

Contrasts of Academic Groups Based on Scheffe' Procedure
Using Adjusted Science Score Means for Test Form I
(Welding)

	General	Vocational
College Prep	F = .04 (NS) X dif = -.41	F= 167.99 ** X dif = -19.99
General		F= 156.54** X dif = -19.58

** Significant at $p \leq .01$ NS = Not significant

Table 59

Contrasts of Academic Groups Based on Scheffe' Procedure
Using Adjusted Science Score Means for Test Form II
(Home Economics Food Service)

	General	Vocational
College Prep	F = 11.44** X dif = 7.57	F= .23(NS) X dif = -.80
General		F= 26.45** X dif = -8.37

** Significant at $p \leq .01$ NS = Not significant

Table 60

Contrasts of Academic Groups Based on Scheffe' Procedure
Using Adjusted Science Score Means for Test Form III
(Carpentry)

	General	Vocational
College Prep	F = 2.31(NS) X dif = 2.35	F= 96.33** X dif = -10.99
General		F= 152.81** X dif = -14.14

** Significant at $p \leq .01$ NS = Not significant

When contrasted with the college prep groups, based on adjusted scores, the vocational groups perform at a significantly higher level on three of the six measures and are equal to or exceed the college prep groups on the remaining three measures (these latter three contrasts show no statistically significant differences). This is in slight contrast to the unadjusted means analyses. The downward adjustment of the college prep group scores either brings the values of the vocational group in-line with the college prep group or the vocational group significantly surpasses the college prep group. The college prep group means, when adjusted for academic ability, are significantly greater than the corresponding means for the general academic groups on three of the measures; the college prep group adjusted mean scores are not statistically different from the general group on the remaining three measures. The adjustment downward of the college prep group mean in the case of the Home Economics Food Services Math test results in a nonsignificant difference between the college prep group and the general group; this difference was statistically significant when unadjusted mean values were used. The adjusted scores for the vocational groups are significantly higher than those of the general groups on all six tests.

In general, the results of the unadjusted and adjusted group means analyses are consistent. Out of 18 pairwise contrasts, five changes in findings were observed. These changes, a downward adjustment of the college prep group scores resulted in a nonsignificant differences between the college prep and general groups where there was a significant difference in the unadjusted values, and in the other case, resulted in a nonsignificant difference between the college prep and vocational groups where there was a significant difference in the unadjusted values.

Discussion

The present study represents an effort to determine the performance of students participating in vocational education programs in the state of Ohio. This report is presented in three major parts and therefore the discussion has been developed to conform to this structure.

Part I Test Description

Part I of this report presented a descriptive analysis of instruments used in the Ohio Vocational Education Tests (OVET). This aspect of the study was designed to address the first objective. As such, the science and mathematics content of each of the 38 vocational tests was examined. In addition, the Short Form Test of Academic Aptitude (SFTAA) was described.

First, the number and percent of math and science items on each exam was presented. These numbers were derived by math and science content area experts who systematically reviewed and characterized the items on each exam. The minimum number of math and science items on any of the tests is 4 and 2 respectively; the maximum number of math and science items on any of the tests is 121 and 264 respectively. The math items represent anywhere between one and 40% of the total test in a given vocational area and the science items represent between one and 79%. The average number of math

questions across all 38 tests is 34.4; the average number of science questions across all 38 tests is 86.3. The number of total test items across all 38 tests range from a low of 269 to a high of 384; the average number of items on any test is 334.1. Only four of the tests have fewer than 300 items.

As can be seen, there is great variability in the number of science and/or math items across the 38 tests. Generally, there is a sufficient and reasonable number of math items on each of the tests to provide the user with a sound indicator of the student's basic mathematical skills in selected areas. In general, this is also true for the science items. There are, however, seven tests which appear to be overweighted with science items and four tests which have minimal science coverage. Each of the 38 tests is then presented in some detail. The specific subtests of each test were identified and the math and science content areas were delineated. A sample math and science question from each test was included.

The areas of concentration for the 38 tests mathematics content is focused on basic math (all 38 tests; 15 of the tests have some geometry; 3 have some algebra; and, one has some trigonometry). The areas of concentration for the science content across all 38 tests is more varied. Physics and chemistry lead the way with emphasis on 32 and 25 of the tests respectively. There is a large drop to the next grouping (psychology 10, physiology 9, microbiology 8, anatomy 6, botony 6, geology 2 and zoology 2).

The math test items appear to yield reasonable indicators of a student's knowledge of basic mathematics and perhaps of elementary geometry (depending on the test area). The items tend to focus on application of concepts to solving problems rather than simple recognition or recall items. The science test items on the other hand are not easy to cluster into homogenous units.

and therefore it is difficult to generalize across the 38 tests about the specific content of "science". Rather, each test yields an idiosyncratic cluster of science content. Obviously there is a different examination for each of the 38 vocational areas.

Each test has a different number of total items and the number of math and science items also differ from exam to exam. Further, the nature of the items differ across exams; each exam has been constructed such that the items reflect not only science and math concepts, but also contain ideas, concepts and knowledge relevant to the particular vocational area being tested. For example, the welding test use items that reflect the application of math and science to welding; the carpentry test uses items that reflect the application of math and science to carpentry, etc. However, the science items have a tendency to rely on recognition or recall of information in order to respond to the items; some items require the students to make some use of the information to respond to the item while others do not. The ratio and nature of math or science items to the total number of items on the test reflects the requirements of the occupation.

The internal consistency (reliability) of each of the 38 exams is very high (approximately .90 or above) and the item analyses of each exam revealed excellent psychometric properties.

Unlike the vocational tests which are specific to each area, the SFTAA is used as a general indicator of academic ability and is therefore not specifically geared to vocational content. Rather it reflects a series of four generic subtests. The four subtests are sequences, analogies, vocabulary and memory. The sum of the four subscores yields the total score. The instrument was developed and published by CTB/McGraw-Hill and takes about 30 minutes to administer. This instrument has good psychometric

properties and while it has not been revised since 1970 still appears to provide a good indicator of overall academic ability.

The SFTAA when used in conjunction with the vocational tests, provide the user with a reasonably good indicator of general academic ability and specific paper and pencil evaluation of a student's knowledge in a given vocational area.

Part II Performance Levels of Students in Vocational Education

Part II of the report presented normative information on juniors and seniors in the state of Ohio who participated in each of the 38 Vocational Education Tests. Norm data were provided for juniors and seniors from 1984 which reflected their performance on the math and science items of each test. In addition, norm data were provided for these same groups on the SFTAA. The data on the science and math items were presented in two ways. First, the average percentage of correctly answered questions for science and math was generated. Then, the average raw score on these variables was also calculated. These two analyses addressed the second and third objectives of the study i.e., a) determine the proportion of juniors and seniors participating in vocational education programs in Ohio who correctly answer items which reflect science and mathematics content in each of the 38 vocational areas, and b) determine the level of functioning of students enrolled in vocational education programs in Ohio in the areas of science and mathematics content in each of the 38 vocational areas. This latter objective was also augmented by analyzing the raw score performance of all participants general academic ability through use of the SFTAA.

The numbers of students participating in each of the tests varies considerably across the 38 areas from a low of 29 to a high of 1911. In

general, several hundred or more students are reflected in the data for each area. Further, there is no reason to suspect that the participants are somehow atypical of vocational education students in general; there is good reason to believe that these students are representative of vocational education students and that the data presented reasonably reflects the math and science knowledge of the students in each respective area. The norm data presented here are highly consistent with data from previous years and the succeeding year. This interpretation also maintains for the SFTAA data.

The individual items on each test were designed so that student's paper and pencil knowledge could be adequately assessed. The level of difficulty of the items, and subsequently the exam, was developed so that a range of scores across students would be possible. There are easy items, average difficulty items and difficult items. The procedure eliminated both "floor" and "ceiling" effects where students perform at a very low level by missing most of the items or at a very high level by getting most of the items correct. These same tests also needed to accommodate first year students (juniors) and second year students (seniors). Therefore the tests were "pitched" at a level of average item difficulty of approximately .50. The data reflected these characteristics. Group percentages have been used to allow for a common base of comparison across vocational areas because there are different numbers of science and math item on each of the 38 tests and comparison of raw scores across the tests is not meaningful. Percentages were also used because they are relatively easy to understand and convey meaning to the general reader.

Seniors on the average outperformed their junior counterparts on 36 of 38 areas on the math tests. A similar result was found for the science tests (36 of 38). The result is consistent with anticipated outcomes as one would

expect students in the second year of a program to perform better than students in the first year of a program. This same junior-senior difference was also reflected in the SFTAA data.

Further, average performance by the senior level students in each of the 38 areas is generally around the 50% level in both the science and math areas with a range on the group performance in science of a low of 36% to a high of 66%. The corresponding range for the math was 38% to 75%. The average performance by the junior level students in each of the 38 areas was somewhat lower than the 50% level established by the seniors on both the science and math items. The range for the average performance by the junior level students for the science items across the 38 areas was from a low of 32% to a high of 69%; the corresponding range for the math items was from a low of 31% to a high of 74%.

This variation in relative performance across vocational areas probably reflects two things. First, a difference in the difficulty level of the test items across tests, and, second, a difference in academic ability across vocational areas. The latter point is well reflected in the relative performance of groups of students on the SFTAA as the average performance of the groups on raw score is approximately 50 with a range of 41 to 59. Obviously students in certain vocational areas are, in general, more academically able than students in other vocational areas. Juniors are less academically able than their senior counterparts.

The OVET instruments have been constructed and used following norm referenced principles. As such they conform well to those test construction principles and average performance on any one test is getting approximately half of the items correct.

These data reflect a variation in student performance in science, math and academic ability across the 38 vocational areas. This performance in each area appears to be at a reasonable level. This finding seems to be consistent regardless of whether one examines the data based on percentages or raw scores.

Two cautions must be put forth at this time. The first is regarding the stability of the data results for those areas where there are small numbers of participants (less than 50). In these two cases, the results could shift if larger numbers of student data were available. However, these data are thought to be representative and therefore the results are not likely to change even with larger sample sizes. In addition, the number of vocational areas where this situation pertains is small.

The second caution has to do with the number of items contained in science and math. When the number of items in a given area is small (less than 10), percentages can shift dramatically with an increase or decrease of just one item correct on that particular test. This would be the case with science items in four vocational areas and math items in 5 areas. As an example, in one case where the average percent correct for the juniors exceeded the average percent correct for the seniors, the percentages were based on a total of two items.

Finally, there is a considerable range of performance within each of the vocational areas. This fact is reflected in two ways; a) the standard deviation of scores within a test, and b) the maximum and minimum number of correct items. The standard deviations of raw score performance across the 38 vocational areas for science and math for both juniors and seniors (a total of 152 test results) ranged from 1.13 to a high of 42.05. Most standard deviations ranged between 4 and 10 points. The maximum number any

one individual correctly answered varied considerably from test to test (because of different number of items possible) and between juniors and seniors. On 35 of 152 sets of test data at least one person answered all the items correctly. This tended to occur on those areas with smaller numbers of items. In addition, a minimum score of 0 was recorded on 135 out of 152 of the sets of test data. These data lend further credence to the quality of the science and math items as indicators of performance.

Finally, the standard deviation of the raw scores on the SFTAA ranged from 9.33 to 13.86 units with an average value of approximately 11 units. This variability was demonstrated not only across vocational areas but also within each of the vocational areas. Once again, this lends credence to the psychometric properties of the SFTAA and its contribution as part of the Ohio Vocational Education Testing Program.

Part III Comparison of Students in Vocational and Traditional Education Programs

Part III of this report compared the 1985 performance of vocational education students in the areas of Welding, Home Economics Food Services and Carpentry with students enrolled in traditional academic programs (college preparatory and general) on common indicators of science, mathematics and academic ability. This aspect of the study was designed to address the fourth objective. This effort was conducted to investigate the feasibility of legitimately comparing the performance of the vocational program students with traditional academic program students using common indicators of performance.

The selection of the three vocational areas based on the selection criteria turned out to be a very good decision. Two of the three groups were in the middle of all the vocational groups with respect to their general

academic ability as indicated by the SFTAA. The third group was at the bottom of the vocational groups with respect to academic ability. This situation provided a good range in academic ability and provided good groups against which to contrast the academic groups. Further, the Welding, Home Economics Food Services and Carpentry Tests contained typical and reasonable numbers of items in the science and math areas allowing for stability of item performance as well as being representative of other vocational areas in terms of the number of items (See Table 61).

Table 61

Test Items from Three Selected Vocational Tests

	Welding	Home Economics Food Services	Carpentry	Average of all 38 Tests
Total Test Items	333	376	325	334.1
Math Items	40 (12%)	20 (5%)	81 (25%)	34.4
Science Items	68 (20%)	63 (17%)	40 (12%)	86.3

Limiting the number of vocational areas to study as well as restricting the comparison to seniors kept the study at a reasonable and feasible level. In retrospect, these were good decisions. It allowed for some variation among vocational groups (a small sampling) while also allowing for legitimate comparisons and interpretations. The data for the three groups of vocational education students contain large numbers of observations 615, 731, and 820. These sample sizes are fairly typical of all the 38 Ohio Vocational groups. These data are thought to be highly stable and representative of all vocational education students in Ohio in their respective vocational areas.

As reflected on the SFTAA, these groups are fairly representative of all Ohio vocational education students.

The sample of students from traditional academic programs was small. There were 107 students from college preparatory programs and 99 students from general education programs. The number of males and females in each of these groups was fairly balanced. The traditional students come from three local high schools in Central Ohio. These high schools represented a cross section of suburban and rural locations as well as different socio-economic conditions. There was nothing extraordinary or remarkable regarding the schools, communities or their students. The traditional program students were randomly assigned to one of the three test taking conditions (Welding, Home Economic Food Services and Carpentry). Using simple random assignment, the various cell sizes turned out to be fairly well balanced.

The science and math items, extracted from each of the three vocational tests were administered to the respective groups of subjects along with the SFTAA. All three of the tests contain a reasonable number of basic math indicators (14, 19, and 18 items). Two of the tests also contain indicators of geometry (Welding, 25 items and Carpentry, 63 items). From this perspective, the exams are pretty typical of all the vocational exams in that there is a heavy emphasis on basic math. The heavy emphasis on geometry on two of the tests is less typical.

The math items in the Welding and Home Economics Food Service Tests stress the application of principles and concepts (80% and 90% respectively). The math items on the carpentry exam have somewhat less emphasis on application (61%) and some emphasis on basic knowledge 31%). From this perspective the math items from all these tests provide a good indication of basic knowledge of mathematics.

The science items are more varied in their content average. Welding stresses Physics and Chemistry (43% and 57% respectively). Carpentry stresses only Physics (90%) while Home Economics Food Services emphasizes content from six areas (Physics 11%, Chemistry 22%, Botony 3%, Microbiology 33%, Physiology 13% and Psychology 10%). Almost all of the science items represent specific knowledge (information) of the content area (96%, 96% and 86%). From this perspective, the science items are not as good of an indicator of basic science knowledge as the math items are of basic math knowledge. The Home Economics Food Services items present a more rounded view of science, whereas the other two test areas stress specific areas of science e.g., physics and chemistry. Further, the taxonomic level of the science questions stress knowledge appropriate for each specific vocational area. This situation will put students who have not been exposed to the specific content at a disadvantage on these items. For these reasons, the math items appear to be highly valid for use in comparing performance across the vocational, college prep and general program groups. The science items, while adequate, are not in general a good indicator of general science knowledge. Rather, the items concentrate on specific kinds of science (e.g., physics, chemistry), and also focus on items that stress recognition and recall of information rather than the application of concepts and principles. The science items do function but the results coming from their use must be cautiously interpreted.

The three different academic groups were compared using different techniques. First descriptive statistics were calculated (percentages, means, standard deviations and sample sizes). This was followed with a series of one-way analyses of variance on the raw score data. Finally, a series of one-way analyses of covariance were computed on the raw score data.

When using a criterion of academic ability the college prep group is considerably higher than either the general or the vocational groups. The general group and the vocational groups perform at a remarkably similar level. These differences and similarities in academic ability are fairly consistent with what is generally found in the literature. The performance level of all three academic groups of students is at a reasonable level with nothing highly atypical.

When examining the one-way analyses of variance for each area of testing on the math variable, an interesting phenomenon occurs. The performance of the vocational students is not consistent with the relative order of the data found on the SFTAA. The performance of the vocational students on the math variable always significantly exceeds that of the general academic group; the performance of the college prep group is either not significantly different from the vocational group or is exceeded by the vocational group. This situation is not easily explained and is highly inconsistent with the research literature. It appears that in applied basic mathematics, given the constraints of this study, the vocational students are approximately equal to or exceed the performance of students from traditional academic programs.

This pattern also maintains for the performance of the three groups of students across the science items with the exception of the Home Economics Food Services test where the college prep group performs significantly better than the vocational students. The writers are slightly more cautious about the meaning of these findings on the science items because of the previously cited concerns. However, the results are fairly clear and consistent-the vocational students perform at a level that compares favorably with students from traditional academic program. These results maintain even though their

measured academic ability (SFTAA) is less than that of the college prep group and no different from those of the general academic group.

In order to determine and statistically equate for initial differences in academic ability, a series of one-way analyses of covariance were generated using the SFTAA as a covariate. In general this technique had the effect of adjusting the mean score of the science and math dependent variables downward for the college prep group while having minimal impact on the other two groups. As a result, when the three groups were equated on the basis of academic ability and then their performance compared on the respective tests for science and math, the performance of the vocational students always exceeded or was equal to the performance of the other two groups. These results are not consistent with the research literature.

Of course these findings must be interpreted somewhat cautiously. However, based on these preliminary findings, there appear to be rather substantial long term ramifications. It is clear that the feasibility of comparing the performance of vocational, college prep and general academic groups of students on comparable measures has been realized. The next steps in this process appear to be straight forward - increase the sample sizes of the college prep and general academic groups, expand the number of vocational test areas to examine the generalizability of these results, and, to increase the number of school districts participating so that there is good representation of students from traditional academic programs.

Summary and Conclusions

This study was designed to address four basic objectives. The first objective was to report the science and math content contained within the Ohio Vocational Education exams for each of the 38 program areas. This objective was achieved in Part I of the study. Each of the 38 tests was

presented and found to be a good quality instrument (have sound psychometric properties). In general there are reasonable numbers of science and math item on each of the tests.

The second and third objectives of the study were to determine (1) the level of functioning and (2) the proportion of correctly answered questions by juniors and seniors enrolled in vocational education programs in the areas of science and mathematics in each of the 38 program areas. This objective was achieved in Part II of the study. In general, the seniors outperformed the juniors in each of the program areas and the level of performance appears to be at a reasonable level. The exams appear to function at a reasonable level according to the way the tests were developed. Performance across the 38 areas on both science and math varied among the different vocational groups. Academic ability varied considerably among the 38 vocational groups.

Part III of the study addressed the fourth objective which was to initiate a pilot study to determine the feasibility of experimentally comparing students enrolled in vocational education programs with students enrolled in traditional education programs on common paper and pencil indicators of science and mathematics performance. This objective was also achieved as the conclusion can be made that such a comparison is feasible. Further this effort demonstrated that performance of students in three vocational education programs compares favorably with students in traditional academic programs (college prep and general academic) with regard to basic applied mathematics knowledge and selected science knowledge. These results are inconsistent with existing literature and popularly held beliefs about vocational education students. Of course these preliminary results must be interpreted cautiously for reasons cited earlier.

Based on these preliminary findings the following steps are strongly recommended.

1. Increase the sample sizes of the college prep and general groups so that the results are assumed to be stable and not as susceptible to sampling fluctuations or non representativeness of respondents.

2. Increase the number of school districts participating in the study for the traditional groups of students so that greater generalizability of findings is possible.

3. Expand the number of vocational test areas to assure stability of results across the other vocational areas.

Following implementation of the above recommendations and should these results maintain, these data have obvious and far-reaching implications for education in the State of Ohio. At this point in time, there is no reason to assume that those results will not maintain.

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